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ORIGINAL ARTICLES.

I.—Eminent Living Geologists: The Rev. Professor T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S., F.S.A.

(WITH A PORTRAIT, PLATE XIV.)

THOMAS GEORGE BONNEY was born July 27th, 1833, at Rugeley, Staffordshire. His family is of Huguenot origin, and thus affords yet another instance of the remarkable intellectual enrichment of our country which resulted from the religious persecutions in France. His father, the Rev. Thomas Bonney, son of the Rev. George Bonney, vicar of Sandon, and sometime Fellow of Jesus College, Cambridge, was a man of wide and varied interests, and a hard worker, in spite of feeble health; he was master of the Grammar School, Rugeley, and for many years 'perpetual curate' of Pipe Ridware, a very small parish about five miles from Rugeley. The church was rebuilt through his efforts, and he took great interest in primary education, acting for some time informally as Inspector of Schools in the Diocese. He married a daughter of Edward Smith, a Staffordshire man of independent means, and died in 1853, leaving a widow and ten children, of whom Professor Bonney, then just entering upon his second year at Cambridge, was the eldest. The family inherited some property, but the income it afforded was small for the education of so many.

Professor Bonney's inclination towards natural science was to a great extent inherited; both father and mother were keen botanists and had a general love for natural history, which was shared by all their children. The boys were great collectors of eggs, butterflies, moths, and beetles; but in Professor Bonney's case a special inclination towards geology was first aroused by the gift of some fossils from a relative, a lady who was herself a good geologist, a friend of Buckland, Sedgwick, and others of that generation. Some four years later—he would then be a boy of about 14—he visited Filey with his father and mother, and collected fossils there, so that when, soon after, he went to school at Uppingham he was already bitten.

Of course, no Natural Science was taught at school in those days, but in compensation football and cricket were then regarded merely as recreations and had not attained to their present tyranny, so that the boys were free to take country walks, and were even rather encouraged to do so. Here, then, was an opportunity for fossil-collecting, and though none of the other boys were geologically-minded, several of them were egg-collectors, and as Bonney was that too, his occasional search for fossils was excused as an amiable weakness. Before he left, Bonney was head of the school, and in 1852, having obtained a School Exhibition, he went to Cambridge, entering at St. John's College, where he was fortunate enough to obtain a scholarship at once.

His school-teaching had been chiefly classical (of the Oxford stamp), but he owed to two of the masters a real liking for mathematics, and the Headmaster had given him a taste for literature. While at Cambridge the famous 'Coprolite' pits of the Cambridge Greensand began to be opened, and Bonney was amongst the earliest to collect from the rich and remarkable fauna they revealed. As he was reading for both the Mathematical and Classical Tripos there was naturally no time for attending lectures on science, yet the fame of Sedgwick drew him now and then within the walls of the geological lecture-room, and he had the privilege of hearing the 'old man eloquent'; but a regular course of geological or other science lectures he never attended, and hence to some extent no doubt the individuality and independence of his systematic views. Professor Bonney took his degree in 1856; he was 12th Wrangler, and 16th in the second class of the Classical Tripos. He had proposed to read for the Theological Tripos, but his health failing, he left Cambridge and spent part of the summer at Weymouth and Freshwater, when he made his first acquaintance with the Tertiary fossils of the Isle of Wight; the rest of the Long Vacation was spent in Switzerland. The complete change restored his health, and while abroad he accepted an offer of the Mathematical Mastership at Westminster School. The laborious task of teaching now had the chief claim on his attention, but still left opportunities of leisure, especially during vacation, which Bonney made the most of as he continued the study of geology. He had now also to prepare for the Church, and was ordained deacon in 1857 and priest in 1858. In 1859 he was elected to a Fellowship at St. John's, and returned to that College in 1861 as Junior Dean. Natural Science was then beginning to secure a due recognition from the University. Up till 1861 the Natural Science Tripos, which had been in existence for something like sixteen years, was open only to Bachelors of Arts; but in that year it acquired equal rights, and a candidate could then obtain the degree of B.A. without previously passing through the Mathematical or Classical School. Of late years the candidates for this Tripos have considerably exceeded in number those for either of the ancient schools. The study of Natural Science received, however, but slight encouragement from the Colleges, and Bonney, as soon as he

was well settled down at Cambridge, joined in the movement which was being made to press its claims; an open exhibition in Natural Science was offered by St. John's, partly as a consequence of his efforts. Professor Bonney, in what perhaps may be regarded as an excess of grateful recognition, has been known to say that he owes whatever success he has had in life to the Fellowship he obtained at St. John's; with equal, if not more truth, many who are now engaged in the advancement of scientific learning might say the same of the opportunities which this college exhibition has afforded them.

In the summer of 1858 Bonney paid his second visit to Switzerland, crossing the Strahleck and the Weissthor; his love of the Alps dates from this journey; since then he has returned to them something like two out of every three years of his life. In 1860, 1862, 1863, and 1864 he was chiefly engaged in exploring the French and Italian Alps, then rather imperfectly known. At the end of the last journey he went on to the South of France, and while there fell a victim to malaria, from the effects of which he has never since been entirely free. These, though they prevented him from 'roughing' it as much as he would have liked, did not put a stop to his climbing, which he continued in a steady but not too adventurous way till about ten years ago, and even still he sometimes undertakes an ordinary ascent of 5,000 feet or so. Hence his intimate knowledge of the Alps, which from the Visp to the Salzkammergut is well-nigh unrivalled.

By the year 1868 Bonney's knowledge of geology had ceased to be that of an amateur; the stage of preparation had passed, and having in that year been appointed Tutor he commenced to give College lectures on the subject; in the next year he was formally appointed Lecturer on Geology by the College. He had not enjoyed the advantages which are now open to every geological student, but he had fully availed himself of that strenuous training which we are beginning regretfully to look back upon as the good old-fashioned education. Mathematics had impressed upon his mind the real necessities which are demanded by a proof. Classics had assisted him to cultivate a literary gift, and travel had taught him facts at first-hand. Freshness and reality as a natural consequence were the distinctive marks of his Cambridge teaching. Soon after he commenced to lecture, his great contemporary Sedgwick, yielding to failing health and the increasing infirmities of old age, gradually retired from the active work of his Chair, and thus it fell upon Bonney to keep alive the traditions of the Cambridge School of Geology. How thoroughly alive they were kept his numerous pupils may testify. To his pupils he might be said to have given all he had: he helped them to the utmost of his powers, by lectures, private tuition, friendly advice, and informal teaching in the field; the last took place during Term in the district around Cambridge, and in Vacation in various remote parts of the British Isles. Nor must the social gatherings be forgotten, when his students made from time to time the acquaintance of the leading geologists of the

day. In this self-devotion Bonney was perhaps too careless of advancing his own reputation; the Long Vacations were spent in investigation and research, but Term left little or no time to prepare the results for publication, and hence his fame fell behind his merits. This was unfortunate; it injuriously affected his claims when he stood for election to Sedgwick's Chair, and he was defeated by 6 votes. The range of his teaching was very wide; even in those early days he had recognized the 'one in the many' of earth-knowledge, and while on one occasion he would describe in detail the structure of a single mountain, on another he would treat undauntedly of the earth as a whole. Physical Geography was taught in a way to convince students that, if they wished to become geologists, they must also be meteorologists, hydrographers, and geographers as well; but Cosmogony was by no means banned, and some knowledge of Astronomy was essential, so that unless they exercised great care his students might find themselves unexpectedly knocking their heads against the problem of the 'three bodies.' Palæontology was the subject of a course, and in 1873 one on Petrography, practically illustrated by the microscope, was added. This was among the first courses of systematic teaching in modern Petrography given in the British Isles, probably the very first. From it Teall and Sollas (not to mention others) gained their first insight into this branch of Geology. A list of those who attended the general course on Geology would be interesting reading, but without it the names of J. E. Marr, A. Strahan, Jukes-Browne, Clough, W. W. Watts, R. D. Roberts, Milnes-Marshall, P. H. Carpenter, and F. M. Balfour may be recalled, as well as those first mentioned. F. M. Balfour will be best known as the bright particular star of the Biological School, but his interest in Geology at that time is shown by a clever paper written in conjunction with his cousin, Gerald Balfour (late Chief Secretary of State for Ireland), to explain the downward dip of the beds surrounding a volcanic neck.

The thoughts of an old student often wander fondly to those early days spent under Professor Bonney's paternal care. Let us set out on one of those reminiscent journeys. Here is the bold portal of St. John's; we turn in, cross the first quad, and enter that beautiful second court, so justly praised by John Ruskin; in the middle of the left-hand side is an entrance which leads to a narrow staircase, and on the first landing we read over a door, in white letters on a black ground, Rev. T. G. Bonney. We knock and pass into the outer room, furnished in the austere beauty of ancient oak; a massive lecture-table stands in the middle, and at the nearer end is a bookcase full of white-vellum covered volumes containing presentation copies of scientific pamphlets. This is the lecture-room, and somehow it impresses us; there is a feeling as of an ancient University in the air, and when the tall spare figure of the Tutor approaches to welcome us we seem to realize an idea already formed in the mind as an expression of the *genius loci*. He leads us through a door at the other end into his private sanctum, a bright and cheerful chamber, the walls lined with books, except

above the fireplace, whither our eyes are drawn by the vigorous yet delicate outlines of Alpine ranges, displayed in long panorama, the fruits of the Professor's pencil in Long Vacation rambles. The Tutor takes his seat at the table, and perhaps spends a good half-hour in a running commentary on the answers we have given to his preparatory examination papers, or, it may be, discusses with stimulus and advice some budding idea which by an artful kindness he leaves us to imagine is as interesting to him as to ourselves. Out of this room a door leads into another, larger, and by its light and elegant furniture proclaimed the drawing-room; on the walls are many beautiful glimpses of mountain scenery in the dream-like colouring of Elijah Walton. This is the place of many a social gathering, especially after Chapel on Sunday evenings: there you, an undergraduate, just out of your teens, may meet Adams of Neptunian fame, and recognize, to your surprise, that he is really a fellow man; Miller, the most exact of mineralogists, will probably be there; and sometimes there are ladies, and the gracious presence of Miss Bonney, the Tutor's sister. This time it is the last meeting in the May Term, and we discuss the coming Vacation ramble; a few weeks, and the scene has shifted to the Lizard, where the class, nearly a full score strong, is hammering out the mysteries of gabbro and serpentine, and hornblende-schist. There is Teall, he is very busy over a supposed Troctolite at Coverack, and by his side Jukes-Browne, adherent with argument; Milnes-Marshall is on the beach sketching a queer dyke over which Sollas is climbing with cat-like agility; R. D. Roberts is busy with a notebook, and Strahan is discussing with the Professor a question of intersection, whether the gabbro cuts the elvan or the elvan cuts the gabbro. It is a long sunny day; at its close the Professor presides at a frugal meal, and we come home to quarters by boat; Edmund Kelly, with his clean-cut Greek profile, wearing a Phrygian red cap, takes the helm and steers with the courage of an ancient Viking. Such were those days when life was young and tobacco was sweet, and our revered Professor was a great boy like the rest of us, only infinitely more wise.

In 1877 Bonney was elected Professor of Geology in University College, London, but still continued to lecture at St. John's; in 1881, on being appointed Secretary of the British Association, he finally quitted Cambridge and took up his residence in London, on the borders of Hampstead Heath.

On an endowment accruing to the Chair in University College in 1885, he resigned the Secretaryship of the Association in order the better to devote himself to the professorship. This, however, was very uphill work; single-handed, and unprovided with modern appliances, he found himself set to make bricks without straw. To add to his difficulties the effects of the agricultural depression now began to make themselves felt, and he found it necessary to supplement his income by literary work; thus commenced his connection with one of the leading London journals, for which he still continues to write. In 1901 he resigned the professorship and was succeeded

by Mr. Garwood. One alleviation in his London work cannot here be overlooked, the voluntary assistance rendered by Miss Raisin, who was for several years a zealous pupil and co-worker. She wrote several petrological papers in conjunction with Professor Bonney.

A few years before his retirement, in 1895, the feelings of his old students, both Cambridge and London, found spontaneous expression in the gift of his portrait painted by Mr. Trevor Haddon. The presentation took place in University College before a large and distinguished assembly, and few who were present will forget how on that dull December afternoon a warm glow of feeling seemed to expand and grow luminous as speaker after speaker rose to express his gratitude "to the Tutor whom they had feared, the Master whom they reverenced, and the Friend they loved."

Amidst his engrossing labours as a teacher and investigator in geology, Professor Bonney has found time for work as a literary author. "Outline Sketches of the High Alps in Dauphiné" was published in 1865, "The Alpine Regions of Switzerland and the Neighbouring Countries" in 1868, "The Coast of Norway" (1870), "Vignettes, Alpine and Eastern" (1873), "The Bernese Oberland" (1874), "Lakes and Mountain Scenery of the Swiss Alps" (1874), "Welsh Scenery" (1875–76), "English Lake Scenery" (1876), the letter-press in Walton's "Peaks and Valleys of the Alps" (1867), and in the same artist's "Flowers from the Upper Alps," and much of the descriptive text in such well-known works as "Picturesque Europe," "Our Own Country," "English Cathedrals" is from his pen. Of more particularly scientific works may be mentioned "The Story of our Planet" (1893), "Charles Lyell and Modern Geology" (1895), "Ice Work, Past and Present" (1896), "Lewis; on the Genesis of the Diamond" (1897), and "Volcanos" (1899).

The life of a geologist, the life of an author, have not, however, been sufficient to satisfy Professor Bonney's insatiable industry; he has lived, too, the life of a clergyman. He was one of the Cambridge Preachers at the Chapel Royal, Whitehall, in 1876 to 1878, and has five times been a Special Preacher before the University of Cambridge, on the last occasion being Hulsean Lecturer. These lectures were published in 1885 under the title of "The Influence of Science on Theology." He has also published "The Holy Places of Jerusalem" (1864), "Old Truths in Modern Lights" (Boyle Lectures, 1890, 1891), and "Doctrine and Modern Thought" (Boyle Lectures, 1891, 1892).

He is an Examining Chaplain to the Bishop of Manchester and an Honorary Canon of that Cathedral. He frequently preaches in London, and those who listen to him will recognize the same independence of thought and variety of mood which distinguish his scientific lecturing; at one time the hearer will be charmed with a rare eloquence, at another he will enjoy that keen satire which once led to the remark "Professor Bonney has a tongue like a sword!"

Professor Bonney became Fellow of the Geological Society in 1860; he was one of the Secretaries from 1878 to 1883, and

President in 1884 and 1885. In 1889 he received the award of the Wollaston Medal. He was elected a Fellow of the Royal Society in 1878. In 1886 he was President of the Geological Section of the British Association; in 1888 he delivered one of its Evening Discourses. He has also been President of the Mineralogical Society, is a member of the Alpine Club and has been its President. He is a Doctor of Science, Cambridge, he has received the honorary degree of LL.D. from the University of Montreal, and of D.Sc. from the University of Dublin, which was conferred on the occasion of the celebration of the Tercentenary of Trinity College.

The subject which earliest engaged the attention of Professor Bonney was glaciers and their action; this was at the time when Ramsay's fascinating theory of the origin of lake-basins, developed by that genial and brilliant investigator with his accustomed skill, and urged with all his infectious enthusiasm, had captivated the minds of nearly all the young English geologists. Possibly the more readily, owing to the besetting sin of the so-called Uniformitarian School, which in its neglect of quantitative reasoning was content for the most part to discover tendencies, without proceeding to inquire whether these were sufficient or continued far enough to produce the effect they were supposed to explain. Thus it was urged that since a glacier can be shown to have produced a number of mountain tarns, there is no reason why in sufficient time it should not accomplish the incavation of a lake or an inland sea, such as Lake Geneva, or Superior, or the Caspian.

Bonney's mathematical training had freed him from this fallacious tendency, and his intimate knowledge of the Alps and their glaciers led him to take very different views as to the origin of the Swiss lakes; and thus amongst his earliest papers we find a careful analysis of the problem as illustrated by particular instances, with observations and arguments which led to complete disproof of the erosion theory and a return to views which are more suggestive of the spirit of De la Beche than of Lyell. Glacial problems have from that time to this always maintained their interest for him, and the popular theories of to-day are at present as little accepted by him as were those which first engaged his attention. Whether the present theories will be longer lived than those of the past, time alone will show. From glaciers Bonney next turned his attention to rocks, and here again was led into conflict with prevailing views, which seem to have been inspired by the same pursuit of suggestive tendencies. The remarkable changes produced on sedimentary rocks by what is vaguely termed metamorphic action had led the Lyellian school to assign a metamorphic origin to granite. If a shale may become converted into a slate, or even a mica-schist, why should not the process continue and mica-schist pass into gneiss, and gneiss find its final term in granite? A study of contact phenomena will frequently afford evidence of the continuity of granite with gneiss, and thus but one link remains to be discovered by the connection of gneiss with mica-schist. The imagination sometimes supplied this, and thus a cycle was completed; for, commencing with granite,

this, suffering first disintegration and then deposition, is known to give rise to sedimentary rocks, while these under the magic of metamorphism were supposed to be converted into granite again. Thus a beginning or ending to which Lyellians were always averse was evaded. To insist on the significance of the missing link, and to restore to the igneous rocks their true place in the constitution of our planet, was one of the tasks which Bonney set himself and successfully accomplished. But if where geologists had traced a gradual passage a sharp line of demarcation could be shown to exist, dividing the igneous from the sedimentary rocks, what of the alleged transitions between the various schists themselves? Had imagination played its useful part in their case also? "Metamorphic action is of all ages" had been translated into the statement that "any kind of metamorphic rock may be of any age." This is a formula that Bonney has never been able to accept: the Archæan rocks are for him marked as such not only by their infraposition to the Eozoic systems but also by their intimate structure; and he professes to be able to distinguish them not only in the field but also under the microscope. Whether in this important matter he be in the right or no, again time alone can decide, but whatever its verdict on this point the immense additions to our knowledge which have resulted from his researches into the difficult and obscure subject of the most ancient rocks will always retain a permanent value. The difficulties are sufficient to render it repulsive to most minds, but the less known about a thing the greater are its attractions for Bonney. Charnwood was a true *terra incognita* up to 1877, when Bonney first made known the fragmental igneous character of much of its rock, and afterwards assigned it to a Pre-Cambrian horizon. How thorough his work was in this region will appear from the subsequent investigations and detailed mapping of Professor Watts, who has been known to grumble that Professor Bonney was always right, and has left very little for his successors to discover in this region. From Charnwood attention was next directed to Anglesey, which was found to offer so many perplexities that it was abandoned for a while, and the Alps were again resorted to in the hope that there might be found some suggestive clue to their interpretation. But in the Alps Professor Bonney found himself in *mediis rebus*; he had left the outskirts for the very centre of the arcanum, and ever since has been engaged in trying to decipher the history of the crystalline schists and gneisses in that chain, as well as in other lands. A summary of his views is given in his Presidential Address to the Geological Society in 1885; a more recent account appears in "An Outline of the Petrology and Physical History of the Alps," read before the Geologists' Association in 1897. Of course, while working on such subjects as this, when the facts are often obscure and opinion still fermenting, the chances of controversy are great, scarcely indeed to be avoided, even were it well to avoid them; for it is still true that strife in the domain of things intellectual, as elsewhere, is lord over the ways of evolution, the great eliminator of error, and

thus also the revealer of the truth. Professor Bonney has never shrunk from controversy, and has but little reason to regret it. The exposure of the mistake which had been made over the nature of the "Belemnite-bearing garnetiferous Calc-schist" was well worth a fight; but that the mistake should have been made at all diminishes any surprise that might have been felt at the easy way in which one limb of the great Glarus double-fold yielded at the first serious assault, and was sheared off into the limbo of defunct hypotheses.

The English Trias is perhaps one of the most interesting of our systems, for, in spite of its scarcity in fossil remains, it offers many fascinating problems to the explorer of the unknown; the mystery of the pebble beds in particular appeals to the imagination. Professor Bonney's explanation of these as fluviatile deposits has now become generally accepted, and Continental geologists, like Penck, have extended his views to other cases; nor, indeed, have all the results which are likely to follow from this promising theory yet been harvested.

The history of coral atolls, one of the most important problems now pressing for solution, has for long been a subject of interest to Professor Bonney; the summary of the arguments, for and against Darwin's explanation, which he has given in an appendix to the last edition of Darwin's "Coral Reefs" may be taken as a model of judicial fairness. Subsequently, as Chairman of the Coral Reefs Committee appointed by the Royal Society, he worked hard in the interests of the various expeditions which were sent out from this country and Australia to investigate the atoll of Funafuti, and from which such valuable results have followed.

Professor Bonney's petrographical work is too multifarious for a short epitome; its commencement belongs to the early period of Zirkel and Rosenbusch, and is anterior to the publication of the great classic, "Mineralogie Micrographique," of Fouqué & Levy. Among his earliest essays were explanations of the origin of Serpentine and Luxullianite; later he found an almost unexplored field awaiting the microscope among the older igneous rocks of North Wales; from then onwards till the present we owe to him a continuous succession of studies on igneous rocks from various parts of the world, and among his most recent discoveries is that by which the diamond has at length been traced to its true birthplace and shown to be an original constituent of what is itself a somewhat rare igneous rock, namely, eclogite.

Needless to add that Professor Bonney has been a somewhat extensive traveller: besides the Alps, his most familiar ground, he has travelled in the Pyrenees, Auvergne, Normandy, Brittany, over many parts of Germany and Italy, Norway, Sweden, Denmark, and Canada, which he visited on the occasion of the meeting of the British Association in 1884. Every journey has had a definite geological purpose, usually an attempt to solve some special problem; and the observations which were made were always recorded on the spot, usually with illustrative sketches; the notebooks in which these are accumulated would make a small library. Professor Bonney

possesses considerable artistic power, and at one time sketched a good deal, but of late years he has ceased to do so, except for geological purposes.

When we contemplate the monumental results of Prof. Bonney's prodigious activity we shall surely conjecture that here was a man especially blessed with bodily robustness, and with leisure, the fruit of private means; yet he has always suffered from imperfect health, to which sedentary work was obnoxious, and has all his life been compelled by circumstances to labour for an income. What, then, is the secret of his success? Possibly, mainly method, the habit of doing a thing at once, and doing it only once; the time which most people lose in hesitation, procrastination, and repetition has thus been secured for useful work: but such method is the privilege of those only who are possessed of an indomitable will and of a mind logical to an unusual degree.

In spite of years Professor Bonney is still young: he has accomplished much; much more remains for him to do. With unabated ardour he still presses forwards in the pursuit of truth. That he may attain it, and in no small degree, is the earnest wish of his sincere friends and admirers. We bid him God speed!

LIST OF SCIENTIFIC PAPERS BY PROFESSOR T. G. BONNEY.

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"On the Upper Greensand or Chloritic Marl of Cambridgeshire" [1872]: Proc. Geol. Assoc., 1874, vol. iii, pp. 1–20.

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"Note on supposed Mollusc Borings in the Carboniferous Limestone of Derbyshire" [1870]: Proc. Cambridge Phil. Soc., 1876, vol. ii, pp. 182–183, 266–267.

"On a Cirque in the Syenite Hills in the Isle of Skye" [1871]: Proc. Cambridge Phil. Soc., 1876, vol. ii, pp. 238–239.

"On the Section exposed at the Roslyn Hill Pit, Ely" [1872]: Proc. Cambridge Phil. Soc., 1876, vol. ii, pp. 268–269.

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II.—Preliminary Note on some Recently Discovered Extinct Vertebrates from Egypt. (Part I.)

By CHAS. W. ANDREWS, D.Sc., F.G.S., British Museum (Nat. Hist.).

DURING a recent visit to Egypt, through the kindness of Captain H. G. Lyons, Director-General of the Egyptian Survey, I have on several occasions had opportunities of accompanying members of the Staff of the Geological Survey on collecting expeditions into the Western Desert.

On one of these journeys I accompanied Mr. H. J. L. Beadnell, F.G.S., to the Fayûm, and we took the opportunity of examining the escarpments of Upper Eocene and Oligocene age in a locality from which Mr. Beadnell had previously obtained some remains of Zeuglodonts and Sirenians. On our first visit it was not until we were about to return to Cairo that any finds of importance were made, but on the last day of our stay a number of interesting specimens were found, including portions of the skeletons of a Sirenian (probably *Eotherium ægyptiacum*, Owen),[1] of *Zeuglodon* (? *Z. Osiris*, Dames),[2] and of a small ungulate, as well as remains of reptiles (*Crocodilia*, *Chelonia*, and *Ophidia*). On our return to Cairo it was arranged to go back to this rich locality and make as extensive collections as possible. The results of this second visit were very satisfactory, and a number of interesting specimens were obtained.

The beds from which the remains were collected are, in Mr. Beadnell's opinion, probably of Upper Eocene and Lower Oligocene

[1] Owen, "On Fossil Evidences of a Sirenian Mammal (*Eotherium ægyptiacum*, Owen) from the Nummulitic Eocene of the Mokattam Cliffs, near Cairo": Quart. Journ. Geol. Soc., vol. xxxi (1875), p. 100, pl. iii.

[2] Dames, "Ueber Zeuglodonten aus Aegypten und die Beziehungen der Archaeoceten zu den Uebrigen Cetaceen": Palaeont. Abhand., neue Folge, Bd. i (1894), p. 189.

age. In the present paper, merely very brief notices of some of the more important new forms are given, but subsequently it is intended by Captain Lyons to publish as complete an account as possible of the geology and physical geography of the district, prepared by Mr. Beadnell, with detailed descriptions of the fossil vertebrata by the present writer.

Mammalia.

The mammalian remains obtained include a Sirenian probably identical with *Eotherium ægyptiacum* from the Mokattam Hills, described by Owen on the evidence of a brain-cast only; *Zeuglodon*, including apparently Dames' *Z. Osiris*, and perhaps a second species; and, lastly, several ungulates which are new to science, and are the subjects of the following notices.

Palæomastodon Beadnelli,[1] Andrews. (Fig. 1.)

One of the most important specimens found in the higher beds (probably Lower Oligocene) is the nearly complete left ramus of the mandible of a Proboscidean, which is in many respects similar to that of *Mastodon angustidens*, but belonged to a much smaller and in

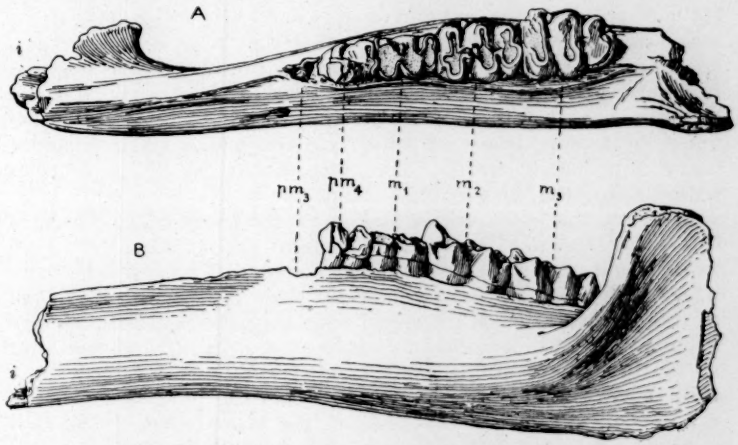


Fig. 1.—Left ramus of mandible of *Palæomastodon Beadnelli*. One-sixth natural size. (A) From above; (B) outer surface.

several respects more generalized form. Remains of *M. angustidens* (or a very closely allied form)[2] were found by Mr. T. Barron and

[1] "Tageblatt des V Internationalen Zoologen-Congresses," Berlin, No. 6, August 16th, 1901, p. 4.

[2] Remains of a small Mastodon from the Lower Miocene (Cartennien) near Isserville (Kabylie), Algiers, have been described by Depéret (Bull. Soc. Géol. France, sér. III, tom. XXV, 1897, p. 518) under the name *Mastodon angustidens*, var. *pygmæus*. The teeth from Moghara, though slightly smaller than specimens from Sansan, are not sufficiently so to justify their reference to this small variety. Moreover, there seems to have been little or no cement in the valleys of these teeth, while in Depéret's specimen it was abundant.

myself in Lower Miocene at Moghara, to the north-west of the present locality, and it seems probable that this mandible may have belonged to an ancestor of that well-known Miocene species.

The mandibular ramus (Fig. 1) is long and relatively narrow from above downwards, and is very slightly decurved anteriorly. It is chiefly remarkable for the elongation of the edentulous region in front of the cheek-teeth; in this region the alveolar border forms a sharp edge without trace of tooth sockets. The symphysis commences about 12 cm. in front of the anterior premolar, but its length cannot be determined, as the anterior portion of the jaw is broken away. Judging, however, by the large size of the central canal at the broken end, it seems probable that the symphysis was considerably elongated, though possibly not to the same extent as in *M. angustidens*. The base of an alveolus for a tusk (Fig. 1, *i*) is preserved on the broken end.

The coronoid process rises from the outer surface opposite the posterior third of the last molar; but its upper part is broken away, as also are the condyle and the angle. The cheek-teeth are distinctly proboscidian, and the molars are very similar to the anterior molars of some Mastodons. There were originally five teeth *in situ*, but the anterior one (pm. 3) has fallen out of its socket, the form of which indicates that this tooth had two roots, a smaller anterior and a larger posterior; probably the crown was triangular in outline. The next tooth (pm. 4) is much broken; it seems to have consisted of a high anterior ridge, a median transverse crest, only traces of which remain, and a small posterior ridge now much worn. The next tooth (m. 1) is likewise trilophodont, the hinder crest being much the smallest. It is much worn and considerably broken on the inner side. The succeeding molars are in an excellent state of preservation. Both are trilophodont, but in the last the hinder ridge (talon) is considerably larger than in m. 2. Each transverse ridge is evidently composed of two tubercles, and is connected with the ridge behind by a very slightly developed longitudinal prominence. Small tubercles occur at the inner ends of the transverse valleys in m. 3. The outer ends of the ridges are far more worn than the inner, which stand up considerably above the rest of the tooth-crown. There is a regular increase in the degree of wear from m. 3 to m. 1. It seemed just possible that the tooth here described as m. 1 might be the last milk-molar, but its state of wear compared with that of the other teeth, and the absence of any trace of a premolar germ in the jaw beneath it or of a molar behind those now described, prove that the interpretation here adopted is the correct one.

It will be seen that this genus differs from *Mastodon* in the greater simplicity of m. 3, and in the fact that two premolars and three molars are in use at once. I propose the generic name *Palæomastodon* for this form, the name of the species being *P. Beadnelli* after Mr. H. J. L. Beadnell, of the Egyptian Geological Survey, to whom the discovery of these fossils is mainly due and by whom the survey of the Fayûm area has been carried out.

The dimensions of the specimen figured are as follows:—

	mm.
Total length of specimen	610
Depth of ramus in middle of diastema	96
,, ,, immediately in front of p.m. 3	105
,, ,, immediately beneath p.m. 4	120
,, ,, at symphysis	97

Dimensions of Teeth (in millimetres).

	Length.	Width.
p.m. 3	41 (of alveolus)	—
p.m. 4	48	33 (approx.)
m. 1	48	37 (approx.)
m. 2	65	51
m. 3	78	53

Approximate length of molar and premolar series ... 285 mm.

Other specimens probably referable to this form are a maxilla with two molars, a nearly perfect specimen of m. 2, a scapula, a humerus, a femur, a tibia, an imperfect os innominatum, an atlas, and an axis.

Mœritherium Lyonsi,[1] Andrews. (Fig. 2.)

In the lower beds of probably Upper Eocene age a great quantity of remains of an ungulate about the size of a large tapir was obtained. These include numerous portions of the skull and mandible, some with the teeth in good preservation, associated sets of vertebræ more or less complete, ossa innominata, femora, humeri, etc. From these it will eventually be possible to obtain a very good idea of the skeletal structure of this animal. Here it will only be possible to refer briefly to the skull and teeth.

The skull is very massively built. The cranial region is depressed, and the stout zygomatic process arises far back and projects strongly outward. The external auditory opening is on the upper surface of the base of this process, and is bordered posteriorly by an outgrowth of the squamosal which grows round it as in the elephants. The brain-case is relatively large. The orbit is small, and the nasals seem to have been rather short, leaving a large narial aperture.

The teeth are remarkable. In the upper jaw the median pair of incisors are small, the second pair greatly enlarged, triangular in section, and form a strong pair of downwardly directed tusks

[1] "Tageblatt des V Internationalen Zoologen-Congresses," Berlin, No. 6, August 16th, 1901, p. 4. The generic name refers to the fact that the remains of the animal were found near the bed of the ancient Lake Mœris. The species is named after Captain Lyons, Director-General of the Egyptian Geological Survey.

Schweinfurth, in his account of the Fayum (Zeitschrift der Gesellschaft für Erdkunde zu Berlin, 1886, Bd. xxi, p. 139), states that in a hill about 12½ miles west from the temple discovered by him he collected a jaw of *Zeuglodon* and two mandibular rami of a creature resembling a pig or tapir and corresponding in many respects to *Chœropotamus*. These specimens were afterwards described by Dames, who (*loc. cit. supra*) states that the so-called *Chœropotamus* jaws are in fact the anterior ends of mandibles of *Zeuglodon*. It seems not improbable, however, that Schweinfurth was more nearly right, and that the specimens actually belonged to the present species. A further examination of these specimens is desirable.

(Fig. 2B). Immediately behind the large incisor are two small teeth (represented only by alveoli), the anterior one probably being the third incisor, the posterior the canine; behind this is a diastema of some length (about 27 mm.). (Fig. 2A.)

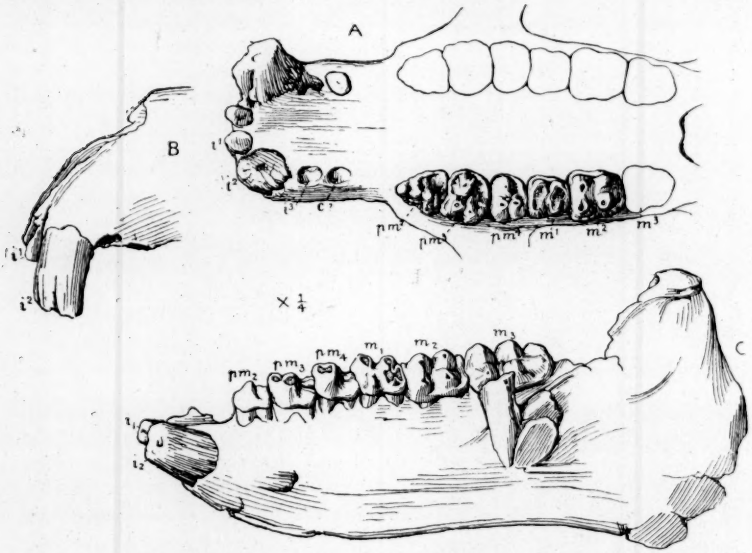


FIG. 2.—Dentition of *Mœritherium Lyonsi*. One-fourth natural size. (A) Upper teeth; (B) front of snout, showing the tusk-like second incisors; (C) left ramus of mandible from outer side.

The cheek-teeth are six in number. The anterior premolar (pm. 2) consists of an outer wall composed of four blunt tubercles, of which the middle two (protocone and tritocone of Scott's nomenclature) are largest and subequal. The anterior (? parastyle) and posterior (? metastyle) are smaller. The inner side of the tooth forms a broad triangular shelf-like edge, worn into a concavity by the tooth below. The next tooth (pm. 3) has two external tubercles (proto- and tritocone) and a large inner tubercle (deuterocone). The cingulum is well developed, and forms a shelf-like hollow on the posterior border. The next tooth (pm. 4) is similar. The first molar is bilophodont, but the crests, which are completely separated by the transverse valley, are distinctly composed of two tubercles, those forming the anterior one being the paracone and protocone, those in the posterior the metacone and hypocone. The cingulum is well developed on the inner and anterior border of the tooth, less distinct on the posterior, and absent on the exterior border. The next tooth (m. 2) is similar, the last is wanting in the specimen described.

The mandible is very solidly constructed, the rami being thickened and very convex from above downward on the outer

surface. The symphysial region is massive and spout-like. The dental foramen is beneath pm. 3. The coronoid process arises from the outer surface of the ramus beneath the anterior end of m. 3, and has a thickened anterior border which often remains when the rest is broken away (see Fig. 2c). The condyle is transversely extended, and is convex in that direction as well as from before backward.

There are two pairs of lower incisors, the first being comparatively small teeth crowded between the second pair, which are modified to form large tusks and are triangular in section. The incisors are procumbent.

The first of the cheek-teeth (pm. 2) consists of a high, blunt anterior cusp, and a low, broad shelf-like talon. The next (pm. 3) has a high anterior crest which seems to be composed of at least two united cusps, and in front of the ridge thus formed there is a small antero-internal cusp. Behind there is a talon with a slight median prominence. The next tooth (pm. 4) is similar, and is, therefore, simpler than the succeeding first molar, which is bilophodont, each ridge being evidently composed of two tubercles. On the outer side there is a distinct cingulum, which on the hinder border of the tooth broadens out into a narrow talon with a median tubercle forming a small third lobe to the tooth. The next tooth (m. 2) is similar, but the talon is larger. In the last molar the talon is large and bears a transversely elongated cusp on its postero-internal border.

The molars show a strong tendency to assume a trilophodont form; in fact, the two last may almost be regarded as having already done so. This circumstance, together with the fact that in both jaws the second incisors are enormously enlarged, while at the same time there is a tendency to suppress the others (the third lower having already disappeared), incline me to believe that in this animal we have a generalized forerunner of the Mastodon type of Proboscidean. This conclusion is likewise supported by some points in the structure of the skull and skeleton. As to the group of primitive mammals to which *Mœritherium* is most nearly related, it is not possible to arrive at any definite conclusion till all the available parts of the skeleton have been examined, but perhaps it will be found to have arisen from some, at present, unknown subdivision of the Amblypoda.

Dimensions of Upper Dentition. (Figs. 2A and B.)

Approximate length of upper pm. and m. series ...	147 mm.
Approximate diameter of tusk	30 ,,
Length of diastema	27 ,,

Dimensions of Upper Cheek Teeth.

	Length.	Width.
pm. 2	27 mm. ...	23 mm. (approx.)
pm. 3	26·5 ,, ...	29·5 ,,
pm. 4	23 ,, ...	27·5 ,,
m. 1	29 ,, ...	27 ,,
m. 2	26 ,, ...	23·5 ,,
m. 3		

Dimensions of the Mandible and Lower Dentition shown in Fig. 2c.

Total length		320 mm.
Height of condyle above inferior border		153 ,,
Length of premolar and molar		172 ,,
	Length.	Width.
pm. 2	22 mm. ...	16 mm.
pm. 3	23 ,, ...	21 ,,
pm. 4	25 ,, ...	23 ,,
m. 1	26·5 ,, ...	24·5 ,,
m. 2	35 ,, ...	30 ,,
m. 3	42 ,, ...	30 ,,

A large part of the skeleton of this animal is known, and will be described in the detailed account of these specimens. Here we may

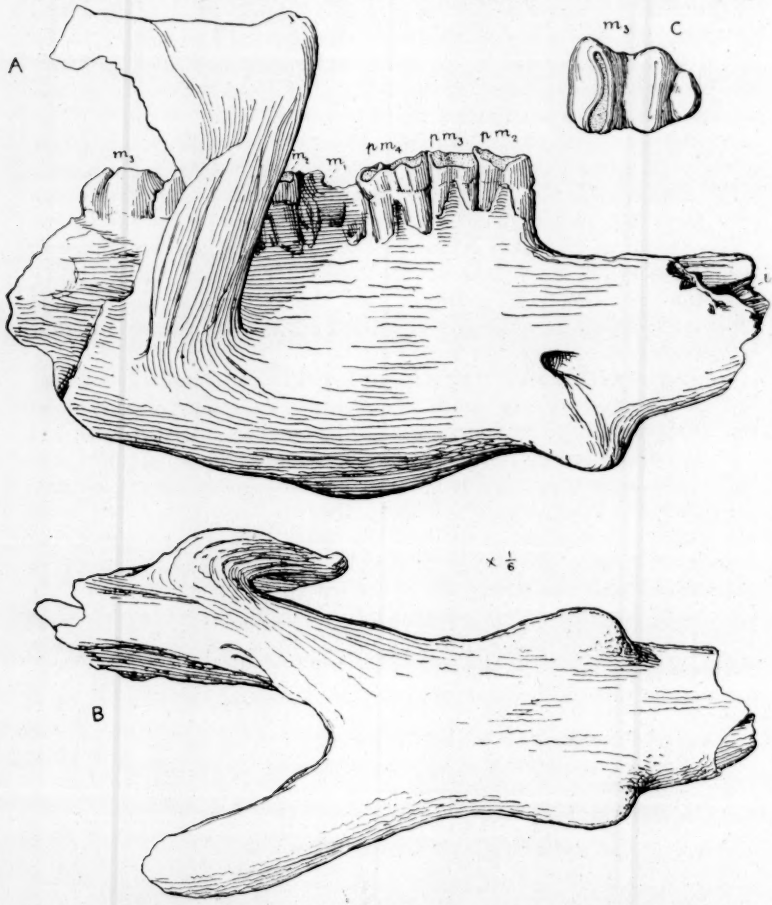


Fig. 3.—Mandible and lower teeth of *Bradytherium grave*. One-sixth natural size. (A) Right ramus of mandible from outer side; (B) mandible from below; (C) third left lower molar.

merely mention that the femur is without third trochanter, and the humerus has no entipicondylar foramen.

Bradytherium grave,[1] Andrews. (Figs. 3 and 4.)

Another very remarkable animal from the lower beds is an enormously heavily built ungulate, which in many respects resembles *Dinotherium*, but in others reminds one of some of the gigantic Amblypoda of North America.

The mandible is shown in Fig. 3A and B. It will be seen that it is a very massive structure. Its inferior border beneath the molar series is convex, and immediately beneath the front of the anterior premolar it bears a stout tuberosity which is directed outward, downward, and forward, and is somewhat similar to the protuberances occurring in the same place in some Dinocerata. In front of this process the lower border of the jaw slopes upward, and forms the floor of the socket for the large tusk-like procumbent incisors. The dental foramen is situated beneath the anterior premolar, and there seem to be two smaller foramina farther back. The coronoid process rises from the middle of the ramus at the level of m. 2. Its greatly thickened border slopes somewhat forward, and rises some 11 cm. above the crowns of the teeth. It then turns back at right angles, but is broken away posteriorly, as also are both the condylar and angular regions. The symphysis is very long (Fig. 3B), commencing beneath m. 1; its upper surface is spout-like and narrows rapidly anteriorly, so that the anterior premolars are only about 5 or 6 cm. apart. In front the pair of large tusk-like incisors are almost in contact in the middle line.

As just mentioned, there was a pair of large tusks, procumbent in position, and close together in the middle line. In this specimen the broken base of the tooth is *in sitû* on the left side, while on the right the alveolus is empty. It is possible that there may have been a second pair of small incisors above the large ones, but the evidence of this is not clear. Behind the incisors is a diastema of about 13 cm. The portion of the alveolar border bearing the cheek-teeth is raised considerably above the diastema. There were three premolars, of which the anterior one (p.m. 2) has a triangular crown; it appears to have three roots, of which one is anterior, the other two arranged transversely posteriorly. The next two (pm. 3 and pm. 4) have quadrate crowns, apparently bilophodont, and four roots. The first molar is greatly broken; it had four roots. The second is bilophodont, and the crown is somewhat longer than broad; there are four roots. The last (Fig. 3C) consists of two transverse crests and a large talon: in this also there seem to have been only four roots, the postero-external one being enlarged to support the talon. All these teeth are greatly worn, especially on the outer side. They are also greatly damaged by exposure to drifting sand. The upper cheek-teeth are also much damaged: those of the left side are shown in Fig. 4. The anterior premolar (pm. 2) is broken on its inner side: it seems to have had three roots, and its crown narrowed considerably in front. pm. 3 and pm. 4 are both four-rooted, and their

[1] "Tageblatt des V Internationalen Zoologen-Congresses," Berlin, No. 6, August 16th, 1901, p. 4.

rectangular crowns are wider transversely than from before backward. Their surface is greatly worn, so that no trace of cusps or ridges remains. The greatly worn m. 1 is similar. m. 2 and m. 3 have quadrate crowns, each composed of a pair of transverse ridges, which are much more worn on the inner than on the outer sides.

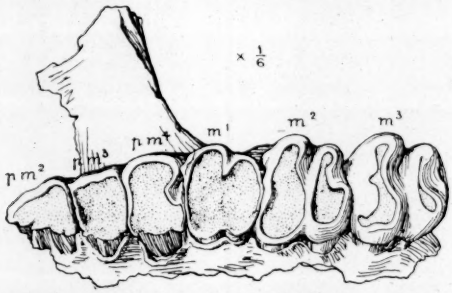


FIG. 4.—Left upper cheek-teeth of *Bradytherium grave*, Andrews. One-sixth natural size.

Besides the mandible and upper teeth here described the collection includes the scapula, humerus, ulna, and some other portions of the skeleton.

The humerus is enormously stout, and its distal end greatly expanded.

This remarkable animal, for which the name *Bradytherium grave* is proposed, in many respects resembles *Dinotherium*, at least as far as its dentition goes, but differs in several points, e.g. in the presence of three premolars and in the existence of a talon on the third lower molar. In some ways, as in the presence of the tuberosity on the lower border of the mandible and in the form of the humerus, it shows some similarity to certain of the Dinocerata. Its actual position remains for the present doubtful. Portions of three individuals were found, so that there is every reason to hope that further search may yield more material for settling this question.

The dimensions of the specimens described and figured are (in millimetres) :—

		Length.	Width.	
UPPER TEETH.—	pm. 2	57	57	
	pm. 3	39	65	
	pm. 4	50	80	
	m. 1	59	84	
	m. 2	75	86	
	m. 3	83	87	
LOWER TEETH.—	pm. 2	51	35	(approx.)
	pm. 3	43	47	
	pm. 4	57	55	
	m. 1	57	—	
	m. 2	86	64	
	m. 3	105	70	

	mm.
Total length of upper molar and premolar series ...	365
Total length of lower molar and premolar series (approx.)	385
Total length of mandible as figured	660
Depth of ramus beneath pm. 4, about	256

The discovery of these Lower Tertiary mammals is of considerable importance, not merely on account of the interest of the specimens hitherto collected, but as showing that much may be expected from further investigation of the Tertiary deposits of the Libyan Desert. At present I am acquainted with (probably) Upper Eocene, Lower Oligocene, Lower Miocene, and Lower Pliocene mammal-bearing beds; and in several localities, during journeys across the desert, fragments of teeth and bones were observed when it was impossible to stay to make any search after more complete specimens, which must no doubt be obtainable. Another point of importance is that the fauna now described differs entirely from that found in deposits of the same age in Europe, and points to the existence of a large land area to the south which had long been isolated. The few species so far obtained can only represent a very small fraction of those which existed, and when found will throw great light on many obscure questions of geographical distribution. One long-standing problem, viz. the place of origin of the Proboscidea, may perhaps be regarded as solved already.

III.—Note on the Discovery of a very fine Example of *Pleurotoma prisca*, Solander, sp. (1766), at Barton, Hants.

By Henry Woodward, LL.D., F.R.S., V.P.Z.S., F.G.S.

In one of his recent visits to the Natural History Museum, Major C. E. Beadnell kindly showed me a fine example of the well-known shell *Pleurotoma prisca*, which had been obtained some years ago by his son, Mr. Hugh J. L. Beadnell, F.G.S. (now of the Geological Survey of Egypt), when collecting specimens from the Barton Clay (Middle Eocene) in the historical cliffs at Barton, Hampshire, whence, prior to 1766, Gustavus Brander, F.R.S., made his famous collection, some of the specimens of which are still preserved in the British Museum (Natural History).[1]

On comparing this shell with the figures in F. E. Edwards' & S. V. Wood's "Eocene Mollusca" (Pal. Soc. Mon.), tab. xxxiii, figs. 1*a–e*, I was surprised to find Mr. Beadnell's specimen greatly exceeded the figured examples in altitude of the spire, as well as in diameter. I therefore requested Major Beadnell to allow me to figure it, to which he at once most obligingly consented.

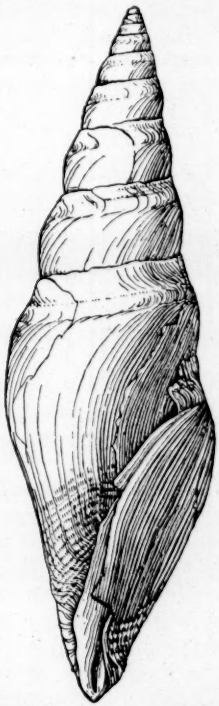
The following is a transcript of Edwards' & Searles Wood's description of *Pleurotoma prisca*,[2] Solander, sp. (1766).

"Shell elongated, fusiform, nearly smooth; the spire almost conical, pointed and moderately elevated, being of equal length with the aperture. The whorls are slightly ventricose; when young, the whole surface is covered with moderately distant, concentric, raised lines, in which state it resembles *Pl. filosa*, Lamk.; these lines, however, are lost on the fourth or fifth volution, and the whorls afterwards become smooth and shining, except at the base and over

[1] Figured and described by Dr. Solander in a work entitled "Fossilia Hantoniensia Collecta, et in Museo Britannico deposita, a Gustavo Brander, 1766."

[2] *Murex prisca*, Brander's Foss. Hant., 1766, p. 16, pl. i, fig. 25; pl. iii, fig. 44.

the posterior margins, round the sutural edges of which last run three or four fine, threadlike, raised lines, occasionally replaced by two or three shallow, obscure furrows; the last whorl is nearly conical, obscurely sulcated at the base and deeply notched at the extremity; the anterior canal is wide, very short, and indistinct. The aperture is narrow and of an oblong-oval form; the outer lip wing-shaped, projecting towards the front, thin and sharp on the edge, and smooth within; the sinus, which is in the very front of the margin, is wide, moderately deep, somewhat triangular in form, and widely rounded at the extremity; the inner lip is much thickened, and is produced and bent outwards in front, giving an umbilicated appearance to the columella, which is slightly twisted and prominently crested towards the base."



Pleurotoma prisca, Solander, sp. Middle Eocene: Barton, Hants.
(Drawn of the natural size.)

There are five specimens figured in Edwards' & Wood's monograph, on tab. xxxiii, figs. 1*a–e*; the largest, *a* and *d*, being from Barton, and measuring 70 and 74 mm. respectively in length, by 25 and 22 mm. in breadth.

Mr. Beadnell's specimen measures 90 mm. in length and 28 mm. in breadth, and is therefore considerably larger than either of the above examples. When, however, we turn to other Eocene species of *Pleurotoma*, we find *Pl. cochlis* attaining to a length of 80 mm.,

Pl. symmetrica to 95 mm., *Pl. attenuata* to 98 mm., and *Pl. rostrata* from 80 to 100 mm.

Amongst recent *Pleurotomæ* there are more than a dozen species which exceed *Pl. prisca* in length of shell, up to *Pl. grandis* from the India and China seas, which attains to a length of 135 mm.

Although Mr. Hugh Beadnell's *Pleurotoma prisca* does not "break the record" for size amongst Eocene species, he may at least claim to have unearthed one of the largest specimens of this genus ever found at Barton.

IV.—On the Limburgite from near Sasbach.

By Canon T. G. Bonney, D.Sc., LL.D., F.R.S.

So much confusion has existed on the subject of limburgite, that, although it has now been partly dissipated, a record of my own investigations may be of use, at any rate to English petrologists. The rock has been classed by some with the peridotites. From these it is separated by Rosenbusch,[1] who in his latest work places it in a subgroup with the augitites in proximity to the basalts. Zirkel uses limburgite as a synonym for magma-basalt. F. Graeff[2] implies relationship with the nepheline-basalts. Harker's[3] remarks suggest similar conclusions, as do those of Cole,[4] though his opening words are perhaps slightly misleading. All, however, lay so much stress upon the absence of felspar, by giving such definitions as "Limburgite und Augitite sind die felspathfreien Entglieder der Gesteinreihe Trachydolerit, Tephrit," etc.,[5] or "Frei von Feldspar und Felspathoiden ist der Limburgit,"[6] and in some cases by reference to the peridotites, that students may readily overlook the fact that this rock is only free from felspar in the same sense as tachylite or many pitchstones and obsidians.

A little consideration of the original analysis should have shown that the rock could not possibly be placed in the same group as the peridotites. This (to which I add a more recent one) gives :—

	(1)[7]	(2)[8]
SiO_2	42·78	44·38
TiO_2	0·28	0·29
Al_2O_3	8·66	9·04
Fe_2O_3	—	12·82
FeO	17·96	
MnO	0·95	0·99
MgO	10·06	10·48
CaO	12·29	12·82
Na_2O	2·31	2·41
K_2O	0·62	0·99
H_2O	3·96	(not given)
	99·87[9]	94·22

[1] "Elemente der Gesteinelehre," p. 361. See also "Mikroscop. Physiogr. der massigen Gesteine," p. 811.
[2] "Mitt. der Grossher. Badischen Geol. Landesanstalt," ii, p. 405.
[3] "Petrology for Students," 1895, p. 179.
[4] "Aids to Geology," 1898, p. 262.
[5] Rosenbusch: "Elemente," p. 361.
[6] Graeff: loc. cit.
[7] "Elemente," p. 363.
[8] From a pamphlet by Professor Steinmann.
[9] Traces also of Cu and Ni.

In eight other analyses quoted by Rosenbusch as representing limburgites we find that

The percentage of	SiO_2	ranges from	40·20	to	44·54
,,	Al_2O_3	,,	8·66	,,	14·89
,,	MgO	,,	6·80	,,	13·34
,,	alkalies	,,	3·50	,,	8·88[1]

But the analysis of a very typical peridotite (dunite) is:[2] SiO_2, 39·61; Al_2O_3, 1·68; FeO, 8·42; MgO, 42·29; Na_2O, 0·01; K_2O, 0·02; H_2O, 5·89. Total, 97·92 (trace of CaO). Among the other analyses of peridotites,[3] we find that the percentage of SiO_2 is often a little higher and that of MgO rather lower, the former rising to about 45, the latter falling even as low as about 20, when, however, the CaO and FeO usually increase, so as to bring the total of the three protoxide bases above 40. The chemical composition of a rock consisting mainly of olivine (i.e. a peridotite) obviously cannot differ materially from that of an olivine; a slight rise in the silica percentage will indicate the incoming of enstatite, or, with addition of CaO, of a monoclinic pyroxene; when the percentage of Al_2O_3 is very low, that is probably present in a spinellid, but with a higher rise (say above 4 per cent.) biotite[4] or white chlorite[5] or anorthite may be expected. Thus, as I pointed out several years ago,[6] limburgite must be much more closely related to the picrites than to the peridotites, and I suggested that it should be regarded as a glassy form of that group.[7]

None, however, of these authors name felspar or a felspathoid as a constituent of limburgite, though some hint at the possibility of their being present, so that it may be worth while to put on record a demonstration of the fact which I obtained in the Summer of 1895. I then collected two varieties of limburgite from a large heap by the roadside, approaching the village of Sasbach, rather more than a mile from the southern quarry at Limburg.[8] One was much less vesicular (or amygdaloidal) than the other, and looked less likely to have a vitreous groundmass, so that on my return to England I had it sliced. Microscopic examination proved it to contain a considerable quantity of felspar, and I should have published a description of it at once had I obtained it from the quarry.[9] So I waited in the hope

[1] Generally under 5·5.

[2] Wadsworth: "Lithological Studies," p. xxiv.

[3] These remarks do not apply to the list given by Professor Rosenbusch, *ut supra*, p. 165, but from personal knowledge I must refuse to admit either the Schriesheim picrite or kimberlite into the peridotites.

[4] As in the mica-peridotite of Kentucky.

[5] As in the Rauenthal serpentines. Here the alumina only amounts to 1·35: see C. A. Raisin, Q.J.G.S., 1897, pp. 251, 257.

[6] Pres. Add. Geol. Soc.: Q.J.G.S., 1885, p. 69.

[7] This is virtually admitted by Rosenbusch ("Elemente," p. 361, and "Mikro. Phys.," p. 813). Zirkel (iii, 76) will not allow even this, and uses limburgite as a synonym for magma-basalt.

[8] Professor Steinmann writes 'Limberg' for the place.

[9] It is not my custom to be satisfied with specimens thus collected. But I had been unable to get a carriage at Riegel (as I had been led to expect), and thus had been obliged to go on foot. It was a hot afternoon, a long and fatiguing walk, and my time was limited by trains, so that I had to turn back without reaching the hill.

that I might either go there myself (it is now more easy of access) or get a friend to ascertain the actual relation of this to the more familiar variety of limburgite. Last Spring, Mr. P. Haas, B.Sc., one of my former students at University College, informed me that he proposed attending lectures at the University of Freiburg, so I asked him to visit Limburg. Early in the Summer he forwarded to me a small box of specimens and a rough sketch of the quarry, on which the position of each was marked, and of which I annex a copy. This quarry, Mr. Haas informs me, is on the south side of the hill marked by the ruined castle of Limburg, near the south-eastern angle; the one from which Professor Rosenbusch obtained and described specimens being on the north-west side, near the ruin and overlooking the Rhine.

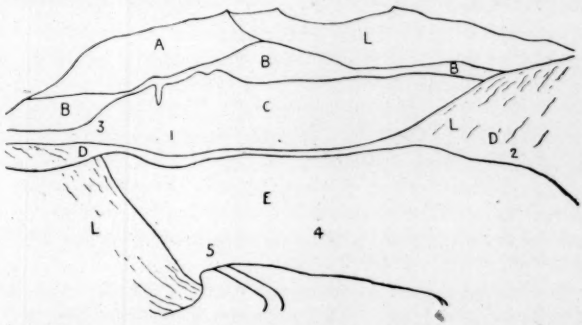


FIG. 1.

A. Upper flow, limburgite (inaccessible).
B. Upper tuff.
C. Middle flow, limburgite.
D. Lower tuff, much foreshortened, with path on cliff edge. All this is covered by slipped-down loess, but Mr. Haas saw the tuff at D and in two places near D', where also limburgite was exposed in two places (2 marking one of them), and the relations of the lava and tuff appeared to be irregular here.
E. Lower flow, limburgite.
L. Loess, often slipped.

The numerals indicate the positions of the specimens described in the text, 5 being the dark rock.

It will save time to arrange the specimens for description according to their structure rather than their situation in the mass. The first (1) has a general resemblance to a specimen (purchased) which has been in my collection for some five and twenty years, except that its vesicles are a little smaller and more thinly lined with (white) secondary minerals.[1] There is a slight but unimportant difference in the tint of the groundmass, and the visible crystals of augite are a little smaller. Microscopic examination proves the larger crystals to be imbedded in a matrix consisting of small elongated prisms of brownish augite, with a few rods of iron oxide,

[1] I have a couple of slices of limburgite, bought nearly as long ago. They show the usual minerals, imbedded in a rich brown glass, in which also are scattered a few microliths, apparently a pyroxene.

and of an interstitial material, which sometimes is a brown glass, sometimes a clear substance, more or less crowded with brown granules. The latter not unfrequently acts on polarized light, and in its clearer parts the outlines of a prismatic mineral, apparently a felspar, may be detected.

(2) Base of the middle mass, right-hand side. The hand specimen exhibits many crystals of black augite about the same size as in the first specimen, and small light-rust-brown spots, indicating partly decomposed olivine, in a chocolate-brown compact matrix. Vesicles are far from numerous, generally not larger than a mustard-seed, and usually filled with secondary white minerals. As the larger minerals—augite, olivine, and iron oxide—as well as the secondary minerals, zeolites and carbonates, in the vesicles, have been so fully described by Rosenbusch in his classic memoir on this rock,[1] I shall content myself with referring the reader to its pages, for they are practically identical. The olivines (hyalosiderite), I may remark, are frequently, though not universally, idiomorphic, and the augites generally show a slight pleochroism. This is more marked in longitudinal sections, giving a distinctly yellowish tint with vibrations parallel to the vertical axis, and puce-brown with those perpendicular to it. As in the normal limburgite, the larger minerals, augite, olivine, and iron oxide, are rather thickly scattered in a groundmass composed of felted minute prisms of puce-brown augite, with specks of opacite, flakelets of ferrite, and some colourless belonites,[2] and a clear interstitial material, which in parts is doubly refracting, but mostly behaves as a glass. This sometimes (though less frequently) is of a rusty-brown colour, and recalls the base of the typical limburgite. These augite prisms do not exceed ·005″ in length, and are commonly four or five times longer than broad. The ferrite flakelets act on polarized light, as do some little prisms of the same colour, but I suspect this material to be little more than a staining. The groundmass, I may add, is not unlike one figured by Boricky.[3]

(3) "From the left-hand side of the middle mass of limburgite," and (4) "From the central part of the pit, a few feet above the floor." Both these specimens hardly differ megascopically from No. 2, except perhaps in being a shade less vesicular; but this is not true of their groundmass, which, however, is so similar in both, that one description may serve. No. 3 contains numerous transparent lath-shaped microliths, up to about ·015″ long, though in one case double of this, and the clear material between these and other microliths (augite, etc.) is doubly refracting, affording low polarization tints, and resembling an indefinitely crystalline mass of felspar. The microliths show the characteristic twinning of plagioclase, and measurements of extinction angles incline me to refer them to labradorite. The small prisms of augite are much less numerous than in No. 2, but generally a little larger. The opacite and ferrite are more or less inclined to cluster in rod-like patterns, and the

[1] Neues Jahrbuch, 1872, p. 33.

[2] I defer the description of these.

[3] "Petr. Stud. an den Gesteinen Böhmens," pl. ii, fig. 8, and pl. iii, fig. 3.

groundmass is rather variable, being in some parts fairly clear, in others a sort of micro-ophite or micropegmatite, composed of ferrite (or some rust-brown mineral) and felspar. The colourless belonites, mentioned already, are rather abundant. Evidently they consolidated at a very early stage, for they are often numerous in the felspar; they have a higher refractive index than the felspar, and the general aspect of fibrolite, but rather low polarization tints and oblique extinction. This prevents me from referring them to that mineral, which otherwise they resemble.

(5) Comes from the bottom of the pit (about the middle), representing the lowest rock exposed. This apparently differs much from the others. Its colour is greenish-black, slightly mottled in places with a paler green, so that the augite crystals are less conspicuous. Cavities are very few, small, and filled with a pale grey-green mineral. Had I been asked to name the specimen without knowing whence it had come, I should have replied, "probably a picrite." But the microscope shows the differences to be only varietal, the colour being due to the absence of the rust-brown iron oxides so common in the others, and the substitution of a green alteration product in the olivines,[1] as is commonly seen in dark-green serpentines. The groundmass of this specimen is also a little variable, some parts exhibiting the intercrystallization of a basic material and felspar described above, while the latter mineral more commonly forms a clear groundmass of fair-sized crystals, in which the others are scattered; it is, in fact, still more nearly a normal holocrystalline rock than any of the preceding specimens.

The specimen which I collected in 1895 is megascopically very like Nos. 2, 3, and 4, but under the microscope presents a close resemblance to Nos. 3 and 4, as well as (allowing for the absence of the green mineral) to No. 5, with one or two varietal differences. The elongated little prisms of brown augite are more numerous than in the latter three; the micropegmatitic structure is much rarer, for it occurs only as an outgrowth from two or three of the large augites; the minerals, large and small (including numerous colourless belonites), being imbedded in a clear material, which (as in parts of those specimens) is a mass of crystallized felspar (without any separate microliths of the same) often showing the characteristic twinning of plagioclase.

When engaged in putting together these notes I learnt from Miss Raisin that she had visited the north-west quarry at Limburg. She has kindly allowed me to examine her specimens, and slices from three of them. The resemblance between these rocks from the original locality and those described above is so close, that a very brief description will suffice. The minerals occurring porphyritically are the same in all. As regards the groundmass: that of a moderately vesicular specimen from about the middle part of the crag is much darkened with opacite and augite microliths, but the clear interstitial material (not abundant) appears to be a glass. Here and there dark belonites (? a pyroxene encrusted with a brownish iron-oxide) occur, arranged

[1] It affects only the exterior, or penetrates into some of the cracks.

in a sort of 'fern-leaf' pattern. The groundmass of a second specimen (almost free from vesicles) taken not far from the bottom of the cliff, very closely resembles those I obtained in 1895. The smaller augite microliths are not numerous, and all the other constituents are embedded in a clear crystalline groundmass of plagioclase felspar. In a third specimen, generally similar in structure, taken from the base of the cliff, aggregated granules of augite occur locally in a similar groundmass, in which I think a little nepheline is also present. Thus, felspar is abundant in much of the rock at both ends of the hill, of which the original limburgite, with the base of brown glass, is only a local condition.[1]

According to a section of the Limburg Hill from north-west to south-east, published by Professor Steinmann in a pamphlet (for

FIG. 2.

1. Upper flow, limburgite (spheroidal).
2. Upper tuff.
3. Middle flow, nepheline-basalt.
4. Lower tuff (with wood, etc.).
5. Lower flow, black limburgite.
6. Upper flow, limburgite (without olivine).
7. Upper tuff.
8. Middle flow, limburgite (with phillipsite, etc.).
9. Lower tuff.
10. Lower flow, ? limburgite or nepheline-basalt.
11. Loess.

From the top of the hill to the bottom of the southern quarry is about 200 feet.

a copy of which I am indebted to Mr. Haas), three flows, parted by tuffs, are exposed in each quarry. He speaks of the top one in the northern quarry as limburgite, the middle as nepheline-basalt, the lower as black limburgite.[2] In the southern quarry, from which the specimens described in this paper are taken, the upper is limburgite without olivine, the middle limburgite, the lower limburgite or nepheline-basalt. Of the specimens here described, Nos. 1, 2, and 3 are from the 'middle limburgite,' Nos. 4 and 5 from the 'lower stream.' I may say that during my examination of these rocks (before I read Professor Steinmann's notes) I was on the look-out for nepheline. Most of the groundmass is indubitably felspar, but one or two small crystals included in that, and a little interstitial mineral (neither very well preserved), are very suggestive of that mineral, which the analysis would lead us to expect.

These notes, I hope, will make it clear to English readers that the typical limburgite (like tachylite) is only a local glassy condition

[1] Miss Raisin informs me that the specific gravity of a compact specimen is 3·058.

[2] Herr F. Graeff (loc. cit.) also gives a section, naming the top and bottom flows in each limburgite and the middle one nepheline-basalt. He notices the different colour of the mass at the bottom of the southern quarry, and says this has a different habit from typical limburgite.

of a rock which elsewhere contains a considerable quantity of felspar, the one passing into the other in the same quarry, and almost certainly in the same mass. In a classification it must be completely separated from the peridotites, for it is related by composition, on the one hand to the picrites, on the other to the olivine-dolerites, and so occupies, whether in its glassy or holocrystalline condition, a transitional position. Thus, if limburgite be restricted to the vitreous type, a new name must be coined for the other one. It is, however, I think, worth considering whether it would not suffice to speak in future of Limburg-tachylite, Limburg-basalt, etc.

V.—Another Section of Keuper Marls at Great Crosby, Lancashire.

By T. Mellard Reade, C.E., F.G.S., F.R.I.B.A.

In 1884 I described in the Geological Magazine a section of Keuper Marls exposed by the excavation of the Boulder-clay at Moorhey, Great Crosby.[1] This was our first knowledge of their existence in the neighbourhood, the whole area being covered with a thick mantle of Boulder-clay excepting where the Lower Keuper Sandstone comes to the surface in the villages of Great and Little Crosby.

The Great Crosby Machine Brickworks Company in extending their operations in Cooks Lane have sunk a well at the bottom of their brick-pit, proving the Boulder-clay to be 35 feet thick from the surface at this point. It is of a remarkably homogeneous constitution and plastic character throughout down to the very base, there being only a vein of sand 1 foot thick at about 3 feet from the bottom. The most interesting result of the sinking is, however, the discovery that it rests upon the Keuper Marls. These Marls are of a bright blue colour and micaceous. From a personal examination of the well I found that here the Boulder-clay rested upon a well-defined surface of the marls which do not appear to be worked up and mixed with the clay. The well had penetrated 5 feet of the Marls, which fail to show very regular bedding, but appear to have a general dip to the south-east. A bed of more gritty material was to be seen on one side of the well, which is 5 feet in diameter, but it became pinched out on the other side.

At a distance of about 440 yards, in a direction 32° south-east, the Lower Keuper Sandstone crops out near the Police Station, so that there must exist between the two places a considerable fault to which may be due the disturbed appearance of the Marls.

It is the intention of Mr. Peters, the managing director of the Company, to ultimately clear out the whole of the Boulder-clay to the full depth over most of the area. It was in this Boulder-clay that the celebrated "Gypsum Boulder of Great Crosby," weighing 18 tons, now erected in the village, was discovered at a depth of about 20 feet from the surface.[2]

[1] Dec. III, Vol. I, pp. 445–7. See also Q.J.G.S., 1885, vol. xli, p. 454.

[2] See "The Gypsum Boulder of Great Crosby": Proc. Liverpool Geol. Soc., Sess. 1898–99, pp. 347–356.

Moorhey, the only other locality where the Keuper Marls have been proved, is about 7 furlongs to the south-east of the Crosby Brickworks, and the Lower Keuper Sandstone of the village intervenes. The Marls at Moorhey, I should say, are somewhat lower down in the series than those just described. If the whole area of the pit is bottomed many interesting facts may come to light.

NOTICES OF MEMOIRS.

I.—Le Dossier Hydrologique du régime aquifère en terrains calcaires, et le rôle de la Géologie dans les recherches et études des travaux d'eaux alimentaires. (Bull. Soc. Belge géol., 1901, x, pt. 5.)—In a paper of some 180 pages Mr. Van den Broeck replies to the note of Mr. Thomas Verstraeten entitled "Hydrologie des roches, necessité de préciser les situations et les termes." The bulk of the paper is of a controversial nature, but Mr. Van den Broeck has brought together a great deal of valuable matter relative to the subject. With a courteous consideration for his readers the author has provided a detailed table of contents, which occupies 12 pages, and from this we gather that the paper deals with the following items:—Hydrology of the Carboniferous rocks; Hydrology of the Chalk; of the district round Han-Rochefort, of Bocq and Hoyoux, and of Remouchamps; the rôle of geology in the search for water and in the application of hydrology, especially in the study of the aquiferous resources of the Carboniferous System; Hydrology of Condroz, and of the horizontal beds of Tournai. The author concludes his paper by saying that it is thanks to the progress of Geology and Spelæology that these practical questions of applied hydrology can be easily solved to the great benefit of human populations.

II.—Maryland Geological Survey: Eocene. (Baltimore, 1901, pp. 332, 64 plates, map.)—The Eocene deposits of the State of Maryland are described in this volume by William Bullock Clark and George Curtis Martin. The description is prefaced with an excellent map and a bibliography. The deposits are divided into two formations, the Nanjemoy above and the Aquia below. Both are rich in fossils, full lists of which are given. The systematic palæontology begins on p. 93, and is treated of by various specialists. The Vertebrata are few in number and consist of four crocodiles and two tortoises, beside the usual tertiary rays and sharks; there are also remains of *Xiphias* and *Phyllodus*. The Crustacea include some interesting Ostracods described by Ulrich. The Foraminifera, of the usual Eocene types, are described by R. M. Bagg, who is doing careful work on these Protozoa, in an area where they have been for some reason much neglected. The Mollusca by Clark and Martin, the Cœlenterata by Vaughan, and the Bryozoa by Ulrich are all well illustrated, and will be of great use for comparison. Two small *Carpolithi* are described and figured by Arthur Hollick.

III.—The Hunterian Oration, February 14, 1901. By N. C. Macnamara, F.R.C.S. 8vo. London, 1901.—This Oration, to which no title is given, seems to deal with the labours of Hunter and others on the subject of craniology and the light which it is capable of throwing on the prehistoric inhabitants of Western Europe, and of the evolution of the race of men to which we belong. Mr. Macnamara points out that the inhabitants of Western Europe in the later Tertiary and early Quaternary period, as regards the ossification and form, especially of the frontal region, of their skulls, more closely resembled that of the chimpanzee than the race of men now inhabiting Europe. Our search for knowledge is still hampered by the limited supply of the remains of man, but a good deal of general evidence has been obtained from the stone implements so common when properly searched for. Mr. Macnamara believes that the evidence collected proves the existence of man in Tertiary times. With regard to the skull of *Pithecanthropus*, he concurs with the conclusion arrived at by Professor Schwalbe, that taking both its form and capacity into consideration, "it is on the border line between that of man and anthropoid apes"; it is more nearly allied to the skulls of the Neanderthal group of men than it is to the crania of the higher apes; but it is much nearer in anatomical characters to the skull of the chimpanzee than it is to the cranium of the average adult European of the present day. The fact that the inferior gyri of the frontal lobes of the brain are well marked, and that the superficies of this convolution of the brain is double that possessed by the largest known anthropoid ape, suggests that the Java man had in some slight degree the faculty of speech, and that his intellectual capacity was higher than that of any anthropoid ape we are acquainted with.

Mr. Macnamara also points out that it should be clearly understood that up to the present no *bona fide* human remains belonging to the early Palæolitic period have been discovered in Western Europe which are not of the same type as those of the Neanderthal group of men, whose fore and hind limbs indicate that they were a short ape-like and powerful race of beings whose average stature did not exceed five feet. The skulls of men found in geological formations of the Post-Glacial period have the same physical type as those of the strictly early Palæolithic epoch of Western Europe, but with increased brain capacity. These skulls, in the opinion of the author, indicate a gradual transition in form from the ape-like characters of the previous period to a higher standard, and certainly to a much greater skull capacity, especially in the frontal region. Mr. Macnamara remarks on the fact that in the recent elections held in this country, when the question at issue was one in which the whole of the people of Great Britain were deeply interested, a large proportion of the inhabitants of England and Scotland, mainly of Anglo-Saxon origin, voted together on the subject; whereas a contrary opinion regarding the same question was held by the greater proportion of the people of Ireland, and to a large extent by the Welsh, most of whom are derived from Ibero-Mongolian

ancestors. It is difficult, he says, to account for this diversity in the sentiments of the people, unless we consider it due to their racial mental qualities.

The Oration is illustrated with an excellent chart of skulls belonging to the Palæolithic, Neolithic, Bronze, and existing races of men.

IV. — Geological Literature added to the Geological Society's Library during the Year ended December 31, 1900. (London, Geological Society, price 2*s*.)—This, the seventh annual record of publications received by the Society, contains 12 pages of titles of serials and academies, of which parts have been added to the library during the past year; 109 pages of titles of papers published in those parts and other separate publications received; and 80 pages of treble-entry, double-column index, analytic of the titles recorded. The work, which is compiled by the librarian, Mr. Rupert Jones, and edited by the Secretary, Mr. Belinfante, deserves to be more widely known than to the Fellows themselves, especially as it is published at so cheap a rate. It provides the best general annual list of geological literature, the index being of especial value, and might be made a really first-class record, if the Society would spend a little more money upon it and include all publications of a geological nature whether received by the Society or not. This system of recording—an alphabetical list, properly indexed—is far and away the most convenient form, and its handy size can be favourably contrasted with those clumsy quartos which are the bugbear of the ordinary man's library.

V.—Buliminæ and Cassidulinæ.—No more useful work is done than that of monographing particular groups. Carlo Fornasini, most active of the students of the Foraminifera, has just published a paper on the Italian forms of these genera (Boll. Soc. Geol. Ital., xx), which he divides into 75 species. He has also published a paper on the Adriatic forms of the genus *Bulimina* (Mem. Ac. Sci. Ist. Bologna, ix). Taking the two papers together they form a valuable contribution to the subject, one of the most interesting points being the publication of some of d'Orbigny's original drawings of the species founded by him in 1826, and which have since remained difficult of absolute identification. Fornasini has put a note in the Riv. Ital. Paleont., vii, on the dates of O. G. Costa's works on the Foraminifera, dates unknown to Sherborn when he published his Bibliography in 1888.

VI.—Other Foraminiferal Publications to which the attention of the student may be profitably directed are: Brown's list and digest of the papers published during 1899 (Zool. Record); Chapman's Foraminifera from the Lagoon at Funafuti (J. Linn. Soc. Zool., xxviii), which gives us for the first time a correct account of the distribution of these organisms across a lagoon, from side to side of the reef; Adalbert Liebus' Foraminiferenfauna des Bryozoenhorizontes von Priabona (N. Jahrb., i, 1901); and Silvestri's Nodosarine del Neogene Italiano (Atti Ac. Pont. N. Lincei, liv).

VII.—Distribution of Vertebrate Animals in India, Ceylon, and Burmah.—Dr. Blanford, writing in the Proc. Roy. Soc., lxvii, considers that whilst it is quite possible that other explanations may be found, it is evident that the peculiarities of the Indian fauna may have been due to the Glacial epoch. During the coldest portion of the Glacial epoch a large part of the higher mountains must have been covered by snow and ice, and the tropical Oriental fauna which occupied the Himalayas, and which may have resembled that of the Indian Peninsula more than is the case at present, must have been driven to the base of the mountains or exterminated. When the country became warmer, the Transgangetic fauna appears to have poured into the Himalayas from the eastward. Dr. Blanford, after discussing the whole matter, says the theory is only put forward as a possible explanation of some remarkable features in the distribution of Indian vertebrates. At the same time it does not serve to account for several anomalies of which some solution is necessary. If thus accepted, it will add to the evidence, now considerable, in favour of the Glacial epoch having affected the whole world, and not having been a partial phenomenon induced by special conditions, such as local elevation.

VIII.—Sphærical Concretions of Graphite.—The sphærical concretions of graphite in the Granite of the Ilmenj were first noticed by Auerbach in 1856, and afterwards described by Rose in 1872. Messrs. Vernadsky and Schklarevsky now show (Bull. Soc. Imp. Nat. Moscou, 1900, No. 3) that the inclusions in these concretions consist of crystals of the minerals characteristic of the Granite—orthoclase, muscovite, biotite, and quartz. The result of their investigations also show that this form of graphite cannot have had a pseudomorphic origin, as considered by Rose, but ought to be considered as a concretion in a granitic magma, analogous to other cases of large sphæroidal inclusions in granite.

IX.—Geology of Scotland.—The Geological Society of Glasgow has recently distributed vol. xi, pt. 2, of their Transactions for 1897–99, but has dated it 1900. We had hoped that this reprehensible practice had been discontinued in this country, and hope that on the next occasion the Society issues publications it will date them accurately. There is a great deal of interesting matter, of which the following is the chief. The late Dr. Heddle's paper on the structure of Agates occupies twenty pages, and is well illustrated; it may be termed a systematic treatment of the subject. Each form is described in detail, and the whole are grouped in a convenient arrangement according to structure. William Gunn gives a detailed description of the old volcanic rocks of Arran, with notes on the sedimentary rocks associated with them, and an account of the faunæ of those beds. Robert Craig writes of the Greenhill quarries, Kilmaurs, Ayrshire, now closed, and gives an historical sketch of the various discoveries made in them. Peter Macnair treats of the physical geology and palæontology of the Giffnock sandstones, and their bearings on the origin of sandstone

rock generally. This is illustrated. He refutes the view that they were of fresh-water origin, and supposes that the contained organic remains have been destroyed, with the exception of the annelid burrows, which he points out are invariably the last things to disappear from percolated sandstones. John Smith has a paper on the Barite veins of south-west Scotland, which mineral he regards as probably an exfiltration product, leached out of the rocks by water, and afterwards re-deposited by the same agent in the veins, but he cannot yet say which of the rocks it was originally derived from. The same writer has a note on the 'China-clay' mine and the Water-of-Ayr stone bed at Troon, and gives some details of localities for radiolarian cherts in Scotland. Two other papers from his pen are "The Permian outlier of the Snar Valley, Lanarkshire" and "Spango Granite," the boulders of which latter he considers were weathered into shape and ready for transport long before the Glacial Epoch. The other original papers, which are all in abstract only, are: Goodchild, the Dolerite of Aberdour; Macnair, the problem of the marginal Highlands; Smith, detached microliths from the Pitchstone Sill at Corriegills (in full, with a plate); Ballantyne, a Bute post-Glacial shell-bed; Cowie, Glacial phenomena of Loch Ranza Glen, Arran; and Horne, the Silurian Volcanic rocks of the southern uplands of Scotland.

X.—Geology in Norfolk.—There are only two papers on Norfolk Geology in the Transactions of the Norfolk and Norwich Naturalists' Society, vol. vii, pt. 2, 1901. The first, by F. D. Longe, is on the formation of flints in chalk. The second, by Professor Newton, records the occurrence of bones of the common Crane, from peat, obtained so long ago as 1867–69, while excavating the Alexandra Dock at Kings Lynn. These bones show a remarkable variation in size of the tibiæ. In the course of his examination of the Woodwardian Museum collections for purposes of comparison, Professor Newton found a right tarso-metatarsus of the Pelican, which further confirms his own and Dr. C. W. Andrews' statement that the Pelican was once a native of the Fens in this country.

XI.—The Geological Distribution of Extinct British Non-Marine Mollusca.—R. Bullen Newton contributes a valuable paper on this subject to the Journal of Conchology. He shows at a glance the geological range of every recorded species of terrestrial and fluviatile shells, excluding only those with manuscript names, or any forms insufficiently described, from the strata of the British Islands. In his list, as no synonymy is attempted, he has introduced the original generic name under which the shell was described, and gives a bibliography of the subject. From a note appended to his paper, we learn that this list was lent to another person for incorporation in a recent publication, but on reference to that publication we find that Mr. Newton's generosity has been studiously ignored by the author in his preface, though the list has apparently been extensively used.

XII.—Geology of Austro-Hungary.—Part iii of the new geological map of the Austro-Hungarian monarchy has just appeared. It contains two maps, those of the Oberdrauberg-Mauthen and the Kistanje-Dernis districts, with their accompanying descriptive pamphlets by Geyer and v. Kerner. In these pamphlets a full bibliography precedes the descriptive text.

XIII.—Laccoliths of Montana.—Messrs. Weed and Pirsson deal with the geology of the Shonkin Sag and Palisade Butte Laccoliths in the Highwood Mountains of Montana in the American Journal of Science for July, 1901. These laccoliths occur in Cretaceous beds, and show a central mass of syenite, surrounded by transition rock, which is in its turn surrounded by shonkinite, the whole having a rind of leucite basalt porphyry. The authors say that these three laccoliths form a transitional group; the Shonkin Sag is the flattest, and also the lowest, and therefore the one most protected from erosion. Its top, in fact, is just beginning to emerge, and from its laccolitic character would not be so evident if it were not for the trenching in it by the former river action which has given such good cross sections. Square Butte stands much higher and has been exposed to much greater denudation; its cover, save in small areas around the base, has been stripped off, and a considerable part of the igneous rock removed. Palisade Butte, standing at the same level as Square Butte, has suffered from the same amount of erosive agencies, but being smaller in size the relative effect has been greater and the cover has entirely disappeared, as well as a large part of the laccolith, so that around it the floor is exposed and only the central portion of the mass remains. From their observations the authors have been enabled to provide us with an excellent account of these interesting structures, which they have illustrated in a clear and exact manner.

XIV.—Bitumen in Cuba.—S. F. Peckham shows in the same Journal that extensive deposits of solid asphaltum exist near the north coast of Cuba, while springs and wells give indications of the existence of liquid bitumens of varying density beneath the surface, over an area of some 4,500 square miles. He is, however, doubtful if, in view of the enormous production which recent developments in Texas and Indiana promise, that there is at present any encouragement for even experimental drilling in Cuba.

XV.—Geology of London.—As President of the Geologists' Association of London, Mr. Whitaker in his annual address to that energetic body dealt with a subject which he has made peculiarly his own. The result is a valuable summary of the papers which have been written on London Geology (to the base of the Drift) since 1888. No less than fifty-nine papers are summarized, and thus rendered easily accessible to general readers. Mr. Whitaker regrets that tendency to over-division of the beds of the Drift so bewildering, as he says, to "simple-minded people like himself." He has also some pertinent remarks on gravels and their ages.

XVI.—Shorter Notices.—A Geological Map and Report on the Tarcoola District, by H. Y. L. Brown, has just reached us. It is part of the Records of the Mines of South Australia, and deals mainly with gold supply.

The Carnegie Museum at Pittsburgh, which was opened in 1895, is described in the Popular Science Monthly for May, 1901, by Dr. J. W. Holland, the Director. Professor Hatcher is making full use of Mr. Carnegie's special fund for research in palæontology, and it is interesting to read that the most perfect specimen of *Diplodocus longus*, six imperfect skeletons of *Brontosaurus*, and the largest known *Mastodon* are in the Museum.

Mr. J. C. Mansel-Pleydell has published in the Proceedings of the Dorset Field Club for 1900 a paper on the Influence of Climatic and Geological Changes upon the British Flora. His annual address for 1900 dealt with the geological history of Pisces. That for 1901, still to be published, dealt with the geological history of the Amphibia and Reptilia.

CORRESPONDENCE.

A SUGGESTED LINK IN THE 'BREAK' BETWEEN PALÆOLITHIC AND NEOLITHIC MAN.

Sir,—In the very interesting paper by Sir Henry Howorth in the August number of your Magazine, we find that to him the great gap between Palæolithic and Neolithic Man means a great catastrophe. In the present attitude of geological opinion, such a statement appears somewhat startling. But if we restrict the meaning of the word 'catastrophe,' as used by Sir Henry, to the occurrence in ancient times of climatic and physical changes of similar nature to those taking place around us at the present day, though of very much greater intensity, probably no geologist is now so rigidly uniformitarian in his views as to refuse to accept it.

The facts before us are these:—During some portion of the Pleistocene Period, probably owing to the co-operation of astronomical and geographical causes, climatic and physical changes, of an intensity which it is difficult for us to realize, were brought about. One of the results of these changes was the distribution of the Drift. There can be little doubt that when this took place man had already made his appearance upon earth. Indeed, Sir Henry is satisfied with such evidence as we possess that his existence dates back even into the previous Pliocene Period. However that may be, and whether we hold that earliest man was Eolithic or Palæolithic, all physical traces of him disappear, with the exception of his imperishable flint implements and a few doubtful bones; and when he next appears on the scene, he has undergone the very considerable advance in development indicated by his entrance on the Neolithic stage. Sir Henry holds that the great gap between Palæolithic and Neolithic man is coincident and in all probability connected with the distribution of the Drift.

However catastrophic in its occurrence the distribution of the Drift may have been, it is obvious that the progress made by man in his passage from the Palæothic to the Neolithic stage was not characterized by that suddenness which is ordinarily associated with the term. Of the history of that progress, of the place of man's abode during it, we know nothing. There is a true 'gap' or 'break.'

In geology and archæology these two words simply imply that our knowledge as to the periods of time concerned is imperfect, and we always expect to find certain of the missing links of the chain of evidence come to light, which they sometimes do in unexpected places.

Is there any link to be found, however remote, to help to bridge over that extraordinary gap between Palæolithic man and his Neolithic successors? I believe there is one, and that it is to be found in the almost universal tradition of a 'deluge'—a tradition which appears to me to have been handed down from our Palæolithic ancestors through the Neolithic, Bronze, and Iron ages of their successors, and to have reached us as a dim and misty conception of their ideas of the—let us call it very bad weather—of the Pleistocene Period. That the story as conveyed to us from Asiatic sources is very different from that written on the page of the rocks in Northern Europe, is not surprising. All tradition undergoes a process of corruption as it is handed down from age to age, and the particular form in which the deluge tradition has reached us is obviously no exception to the rule. Unfortunately, when such a theory is advanced, it is usually seized upon as a confirmation of the miraculous inspiration of Scripture. It is no such thing.

I cannot claim originality for the theory, because I find in Mr. Tiddeman's "Work and Problems of the Victoria Cave Exploration," 1875, the following passage:—"As similar evidences of a submergence late in the glacial period have been observed over large areas in the Old and the New World, and in both hemispheres, in mean latitudes, it may be that the traditions so common to many races and religions of a great deluge are but lingering memories of this great event. It matters not that these myths all differ in their surroundings. The central core still has the solid ring of truth, albeit masked and disfigured by the rust of time."

I venture to suggest that the theory that the deluge tradition is the one and only link which bridges over the gap between Palæolithic man and ourselves, his descendants, is one which is worthy of more attention than it has hitherto received.

J. Adam Watson.

"Hay Tor," Dennington Park Road, Hampstead.

August 18, 1901.

EOLITHIC MAN.

Sir,—It is remarkable that in a quasi-geological paper by a well-known writer should have been allowed to pass current such a statement as that at p. 340 (Geol. Mag., August issue), to the effect that "Huxley caused McEnery's now famous memoir to be

locked up at the Royal Society for years after his death." The Rev. McEnery's reports on Kents Cavern were finished about 1826, and Professor Huxley having been born in 1825 must have been always under age and without influence in the Royal Society whilst McEnery's paper was supposed to be "lost," but really kept in the background by influence of the Rev. Dean Buckland, who ascribed the occurrence of anything like human implements to burials of late date, as I myself have heard him affirm at a meeting of the Geological Society.

The reference to Professor Huxley in the paper alluded to above is probably only one of the evidences of the hasty character of the paper; but at first sight it appears, not only uncalled for, but unkind.

Some of his friends, like the writer of this critique, will regret Sir H. Howorth's inability to recognize the actual classification of eoliths as practically established by Prestwich, and illustrated in his own and B. Harrison's collections, as well as in the Museum of the Geological Survey, Royal College of Science, the British Museum (Natural History Branch), and elsewhere. Also, it is lamentable that he cannot appreciate Prestwich's lucid explanation of the geological history and settlement of the eolithic gravel of the Chalk Downs, as reproduced in Mr. Bullen's pamphlet, to which he alludes as having read.

To other shortcomings we need not refer; it is a pity that there should be any, for the author is doubtless an industrious gatherer of facts and notions, evidently so when he seems to have searched one set of about twenty volumes, "1829–50" (!), for the history of Ami Boué's discovery of bones near the Lahr (p. 339).

T. Rupert Jones.

EOLITHIC IMPLEMENTS.

Sir,—Sir H. H. Howorth, F.R.S., has done me the honour of mentioning in the Geological Magazine for August my little paper on the above subject.

Like Balaam, having set himself to curse Israel, he has instead blessed them altogether. On p. 342 he says (assuming their identity with palæoliths), "Such remains are claimed to have been found at that horizon [the Forest Bed] in Norfolk by Mr. Abbott and Mr. Savin, in Dorsetshire by Dr. Blackmore, and they have been also reported from the same horizon at St. Prest in France and in the Val d'Arno, north of Italy, in each case the remains of human workmanship being accompanied by those of *E. meridionalis. I believe these finds are quite genuine.*" (Italics mine.) The implements referred to as Dr. Blackmore's, pl. iii in my paper, have, as a matter of fact, an eolithic facies, and Sir H. H. Howorth's admission concedes all that for which Sir Joseph Prestwich's followers contend. "I thank thee, Roderick, for that word!"

Sir Henry mentions five men as upholding eoliths, including their original discoverer, Mr. Benjamin Harrison, and that paladin of

geologists, Sir Joseph Prestwich, who first employed his vast geological learning in their defence; but the list may be largely extended, especially among the rising generation of geologists and anthropologists, not omitting, of course, Professor Rupert Jones and the late acute and careful observer Dr. H. Hicks.

Let the following extract from M. A. Rutot's letter serve as a sample of the encouraging letters received since my paper has been issued. He says: "En Belgique, il n'y a pas beaucoup à combattre pour faire admettre les eolithes comme industrie humaine. Depuis plus de 15 ans, nous sommes habitués à l'industrie Mesvinienne, et la connaissance de cette industrie nous a facilité la comprehension des industries plus primitives, eutel-mesvinienne et Reutelienne, et aussi celle des eolithes d'Angleterre et des silex tertiaires. . . . . Dans la question des eolithes vous pouvez être certain d'être vigoureusement soutenu en Belgique."

["In Belguim, there is not much opposition to overcome in causing eoliths to be accepted as of human workmanship. For more than 15 years we have been used to the work of the Mesvinian period [l'iudustrie Mesvinienne], and our acquaintance with this has rendered easier the understanding of more primitive types of workmanship, e.g., Reutel-mesvinian and Reutelian, as well as that of the English eoliths and of flints of the Tertiary period [des silex tertiares] . . . . . With regard to the question of the eoliths you can be sure of vigorous support in Belgium."]

The time is approaching when there will be few or no sceptics on the authenticity of eoliths, and I thank Sir Henry for having, though unconsciously, ranged himself on their side. By the way, "W. J. Lewis," GEOL. MAG., p. 342, must be a slip for W. J. Lewis Abbott, F.G.S. The late ardent collector of palæoliths was *Henry* Lewis.

R. ASHINGTON BULLEN.

"THE EARLIEST TRACES OF MAN."

SIR,—In this article the author (Sir Henry Howorth, K.C.I.E., F.R.S., F.G.S.) taxes the upholders of Eolithic man with an insistence on their views both "in season and out of season." This charge comes rather strangely from the author of the "Glacial Nightmare," etc., and one is at a loss to see either the force or even the meaning of it. All true workers in any science should gladly welcome from others any fresh views, even if they do conflict with previously accepted ones; and had these tended to strengthen those of Sir Henry, they no doubt would have been eagerly accepted by him, and would always have been in season even if forced.

Sir Henry admits to an obstinacy which he says has been stiffened and his scepticism increased by those so-called Eoliths. Now we all welcome honest scepticism, but surely obstinacy is out of place, or should be, in the truly scientific mind. Obstinacy, too, is generally the outcome of prejudice, and this seems to be the case in this Eolithic question.

He speaks as if the uses of all the Palæolithic implements were well *known*—we can only *guess* at most of them—and expects to find in the Eoliths forms parallel with them, and hence by inference

a race of men of similar habits and modes of life, and because such is not the case dismisses them with a sarcasm. All hairy animals do scratch a great deal, and even Job scraped himself, and so we may infer that scraping with a kind of 'scraper' was common in his by no means very early period. He expects man to have sprung at one bound over the vast period that separates him from the mere animal to that of the comparatively highly specialized being he was in the Palæolithic period. He thus ignores the *fact* that the rudest *existing savage*, who lives mostly on roots, and so needs very few tools of any kind, was far surpassed by Palæolithic man, the hunter of the Mammoth, etc.

In reference to the implements from the Forest Bed we regard them as Eoliths, and even Sir John Evans would hardly class them as Palæoliths. Also Eoliths *do occur* with the Palæoliths both on the plateau and in the valley gravels. Again, as to M. Boucher de Perthes, an exact parallelism exists between his case and that of Mr. Harrison, and one has only to substitute the one name for the other in Sir Henry's account; yet Sir Henry evidently cannot see the identity of position; one wonders much if he would have been on the side of M. Boucher de Perthes. We maintain, too, that Mr. Harrison's case is the stronger, as he has had all the past experience of others to aid him, coupled with the extensive knowledge he has gained since. Sir Henry speaks of thousands of shapeless stones with no classification; let him call and see Mr. Harrison's collection with an open mind. Is it likely that the men who find and bring these stones to those who collect them—and they do *not* bring them by cartloads—*could* do so unless they perceived that these objects had a distinctive type of their own.

But I must now leave Sir Henry to those whom he has directly attacked by name; they will no doubt answer him in greater detail and more conclusively.

F. D. Bennett.

West Malling.

THE LATE REV. J. McENERY.

Sir,—Referring to Sir Henry Howorth's suggestion that Professor Huxley was instrumental in suppressing McEnery's Kents Cavern evidence,[1] it is important to bear in mind that McEnery died in 1841, when Huxley was 16 years of age; that McEnery's MSS. were left in an incomplete state; that they are in the possession of the Torquay Natural History Society; and that they were never in the custody of the Royal Society. The suppression of the Kents Cavern and Brixham Cave evidence is a very long story, and one long subsequent to McEnery's death. The late Edward Vivian, in 1859, in his "Cavern Researches" published the pith of McEnery's investigations, and subsequently Pengelly published McEnery's MSS. in their entirety, so far as they have been preserved, *verbatim et literatim.*

A. R. Hunt.

Southwood, Torquay.
August 10, 1901.

[1] Geol. Mag., August, 1901, p. 340.

RECENT DENUDATION IN NANT FFRANCON.

SIR,—When examining the scene of the flood described in this Magazine last February I could not satisfy myself as to whether any channels had previously existed at the same place. My friend Mr. Dakyns informed me, however, that destruction of culverts is mentioned in a description of the damage done to the road. It is clear, therefore, that former channels did exist, and that the whole of the excavation cannot be ascribed to the flood of last August. I think, though, that the old channels must have been small, for if deposition be a measure of denudation, the recent excavating work done must have been very great.

I should like to take this opportunity to again suggest how valuable some regular record would be of denudation observed at the present time.

EDWARD GREENLEY.

OBITUARY.

BARON NILS ADOLF ERIK NORDENSKIÖLD,

PH.D., FOR. MEMB. GEOL. SOC. LOND., NATURALIST AND ARCTIC EXPLORER.

BORN NOVEMBER 18, 1832. DIED AUGUST 13, 1901.

WITH deep regret, we have to record the sudden death near Stockholm of Professor Baron Nordenskiöld, the eminent Naturalist and Arctic Explorer. Of a Swedish family long settled in Finland, Nordenskiöld was born in Helsingfors, the capital of that country, his father, Dr. Nils Gustaf Nordenskiöld, the eminent mineralogist, who died in 1866,[1] being at that time Director of Mines for Finland. Naturally, therefore, his ardent sympathies were always enlisted in favour of the land of his birth.

His family had long been eminent in science, and his inherent tastes were fostered and developed by the surroundings of his home at Frugård, which contained extensive collections of minerals and natural history specimens, and by his journeys with his father. On entering the University of Helsingfors in 1849 he devoted himself almost entirely to scientific studies, spending his vacations in excursions to the rich mineral localities of Finland. In 1855 he took his degree as licentiate, and was immediately appointed a mining official of the Government. From this post, however, he was dismissed in the same year for having indulged in pleasantries at the expense of the Russian Government at a private students' feast. A temporary absence being deemed advisable, he continued his studies at Berlin, but in 1857 returned to take his doctor's degree at Helsingfors. As ill-luck would have it, however, a deputation from the Swedish Universities was then entertained at Helsingfors, and the young doctor in an after-dinner speech again showed his sympathies

[1] See GEOL. MAG., 1866, Vol. III, p. 288.

too plainly. The affair might have been smoothed over, but Nordenskiöld refused to apologise, and was banished the country.

As may be supposed, the viking philosopher was received with open arms by the Swedes, and after little more than a year was appointed Professor and Keeper of the Mineralogical collections at the Vetenskaps-Akademi in succession to Mosander. Earlier in the same year (1858) he had entered on his Arctic travels by accompanying Torell to Spitzbergen, and in 1861 the two geologists undertook a more complete exploration of the island. Three years later Nordenskiöld headed an expedition, which mapped the southern part of Spitzbergen, and started the great work of measuring an arc of the meridian in those regions. The explorers met with some shipwrecked walrus hunters, however, and were obliged to return, their provisions being inadequate to maintain so large an addition to the party. Nordenskiöld now had higher ambitions, but money was lacking, and turning for help to the rich merchants of Gothenburg he initiated the long alliance with Oskar Dickson, productive of so much good to Arctic exploration. The steamer *Sofia*, which carried the winter post to Gotland, was obtained, and in 1868 Nordenskiöld, with the present cabinet minister, Baron F. W. von Otter, as navigating officer, managed to attain the high latitude of 81 deg. 42 min.—a latitude previously exceeded only by Parry, who in 1827, going with sledges from the *Hecla* in the same direction, reached 82° 45′ N. Subsequently this attainment has been surpassed more than once, as by Charles Hall, who in 1871 reached 82° 16′, Payer in 1874 (82° 5′), A. Markham in 1875–6 (83° 20′), Lockwood of the Greely Expedition in 1884 (83° 24′), while the exploits of Nansen (86° 14′) and the Duke of Abruzzi, 22 miles further north, will be fresh in the memory of our readers.

In 1870 Nordenskiöld set out on a short visit to Greenland to ascertain if possible whether Esquimaux dogs would be suitable for sledge-journeys to the pole. During his stay in Greenland he made an expedition into the interior over the inland ice-sheet and examined the Tertiary plant deposits at Atanekerdluk, where he discovered erect bituminized tree-trunks of Tertiary age *in sitû*, proving that they had grown upon the spot (some were 2 feet in diameter), associated with beds of lignite and layers of dicotyledonous leaves. He also made important observations upon the inland ice-sheet and the glaciers on the coast, and discovered the great blocks of so-called meteoric iron at Ovifak, the largest of which weighed about 19 tons, the next 8 tons, and the third 6 tons. (See Prof. Nordenskiöld's account of his voyage, GEOL. MAG., 1872, Vol. IX, pp. 289, 355, 409, 449, 516, and 88.) These masses are now shown to be of telluric origin and to have been ejected probably in Miocene Tertiary times, with the deep-seated basaltic flows through which metallic iron, of a similar character, is found to be disseminated. His belief in their cosmic origin, however, was fortunate in so far as it led Nordenskiöld to the further study of meteorites, while his observations on the surface of the Arctic ice-fields led to the well-known speculations on the falling of cosmic dust.

Nordenskiöld felt convinced that he could reach a much higher latitude by wintering in Spitzbergen and utilizing sledges. Accordingly he sailed thither in 1872 in the *Polhem*, accompanied by two tenders. Unfavourable conditions of the ice rendered the geographical results less important than he hoped; but he discovered fossil plants of great importance to the history of climatology during former geological epochs. Moreover, with Lieutenant Palander, now the Swedish Minister of Marine, he successfully surveyed part of North-East Land, and in the following July the vessels were extricated from their winter quarters at Mossel Bay, on the north coast of Spitzbergen, and returned home richly laden with important scientific collections.

Nordenskiöld now turned his attention to the exploration of Siberian waters, and in 1875, following the pioneers Carlsen (1869) and Wiggins (1874), he sailed through the Kara Sea to the Yenissei, and ascended the river in a small boat, returning home overland. In the following year, after a flying visit to the Philadelphia Exhibition, he introduced merchandise by sea to Siberia, returning in the autumn with his steamer by way of the Kara Sea and Matotschkim Sound. These experiences gave Nordenskiöld a reasonable hope of accomplishing the North-East Passage, and the King of Sweden, Mr. Oskar Dickson, and Mr. Sibiriakoff at once lent their aid to the project.

In July, 1878, Nordenskiöld, with Palander as navigator, started in the *Vega*, accompanied by two smaller ships. She was the first vessel to double the most northern point of the Old World—Cape Tchelyuskin. She wintered near Behring's Straits, and once more free in July, 1879, reached Japan on September 2. After a triumphal passage home around Asia and Europe, Nordenskiöld was enthusiastically welcomed at Stockholm on April 24, 1880, and laden with honours, being created Baron and appointed a Commander of the "Nordstjerne Orden" (Order of the North Star). In 1883 Nordenskiöld made his second voyage to Greenland, where he investigated the inland ice, and succeeded in penetrating with a ship through the dangerous ice-barrier along the east coast of that country south of the Polar circle, a feat in vain attempted during three hundred years by different Arctic expeditions.

Thus, at the age of 51, he brought to a close a career of exploration comparable in the magnitude of its results with that of a Vasco di Gama or a Maghelhaëns. But his intellectual activity was by no means ended. His own explorations furnished material for numerous books and memoirs, such as the account of his first visit to Greenland in 1870 (see GEOL. MAG., loc. cit.), "The Voyage of the *Vega* round Asia" (1881), and the "Second Swedish Expedition to Greenland" (1885). His professional work as Keeper of the Mineralogical Division of the State Museum in Stockholm led him to contribute many valuable papers to the publications of the Academy of Science and various technical journals, as those in which he described the new minerals Crookesite, Laxmannite, Thaumasite, and Cleveite. Combined with his love of active